

1993

7.3L IDI Turbo Diesel

Service Manual Supplement

1993 7.3L IDI Turbo Diesel Supplement to be Used With FPS-12107-93-1 (Body/Chassis) and FPS-12107-93-2 (Powertrain/Drivetrain). Refer to the Foreword in This Manual for Details.



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INFORMATION**

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INTRODUCTION

Important Safety Notice

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This Service Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each.

Accordingly, anyone who departs from the instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

Notes, Cautions, and Warnings

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transaxle, set it in PARK unless instructed otherwise for a specific operation. If you have a manual transaxle, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific operation. Place wood blocks (4" x 4" or larger) against the front and rear surfaces of the tires to provide further restraint from inadvertent vehicle movement.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on a vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle.
- If it is necessary to work under the hood, keep hands and other objects clear of the radiator fan blades! The electric cooling fans can start to operate any time by an increase in underhood temperature, but only when the ignition switch is in the RUN position. For this reason care should be taken to ensure that the electric cooling fan motor is completely disconnected when working under the hood when engine is not running.



HOW TO USE THIS MANUAL

HOW TO
USE THIS
MANUAL

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Ford Parts and Service Division

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Subjects Covered in This Manual

This 1993 Service Manual covers normal service repairs and maintenance for vehicles sold in the United States and Canada.

How This Manual is Organized

This manual is organized by Group, Section, and Page.

Group

A Group covers a specific portion of the vehicle. The first set of numbers on each page indicate the Group.

				GROUP NUMBER		01-00-1
				GROUP		
				BODY		01
SECTION TITLE		PAGE	SECTION TITLE		PAGE	
BODY, GENERAL SERVICE.....		01-00-1	HANDLES, LOCKS, LATCHES AND MECHANISMS.....		01-14-1	
FRONT END BODY PANELS AND STRUCTURE.....		01-02-1	FRONT WINDOW WIPERS.....		01-16A-1	

NOTE: A Group usually contains more than one Section.

The Groups found in this supplement are:

- 00 – General Information
- 01 – Body
- 02 – Engine/Transmission Mounting
- 03 – Engine
- 07 – Transmission
- 09 – Exhaust System
- 18 – Electrical Distribution
- 20A – Diesel Diagnosis

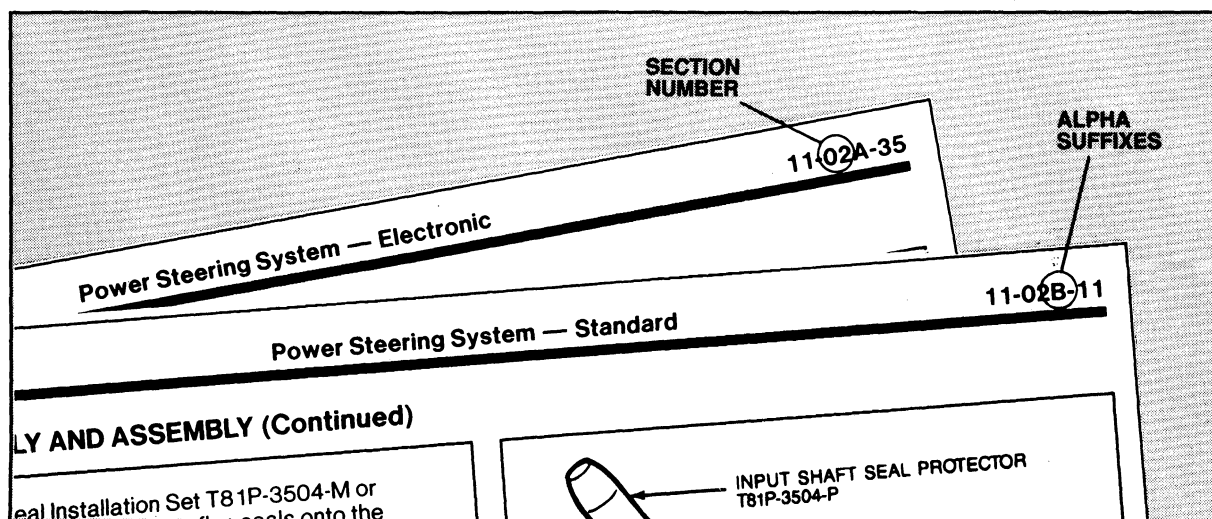
Refer to FPS-12107-93-1 (Body/Chassis) and FPS-12107-93-2 (Powertrain/Drivetrain) for the following groups:

- 02 – Frame and Mounting
- 04 – Suspension
- 05 – Driveline
- 06 – Brake System
- 08 – Clutch System
- 10 – Fuel System
- 11 – Steering System
- 12 – Climate Control System
- 13 – Instrumentation and Warning Systems
- 14 – Battery and Charging System
- 15 – Audio Systems
- 17 – Lighting

Section

Each Section covers a component or system. The second set of numbers on each page indicate the Section.

If the vehicle has more than one type of component, such as two types of engines or power steering systems, alpha suffixes are used.

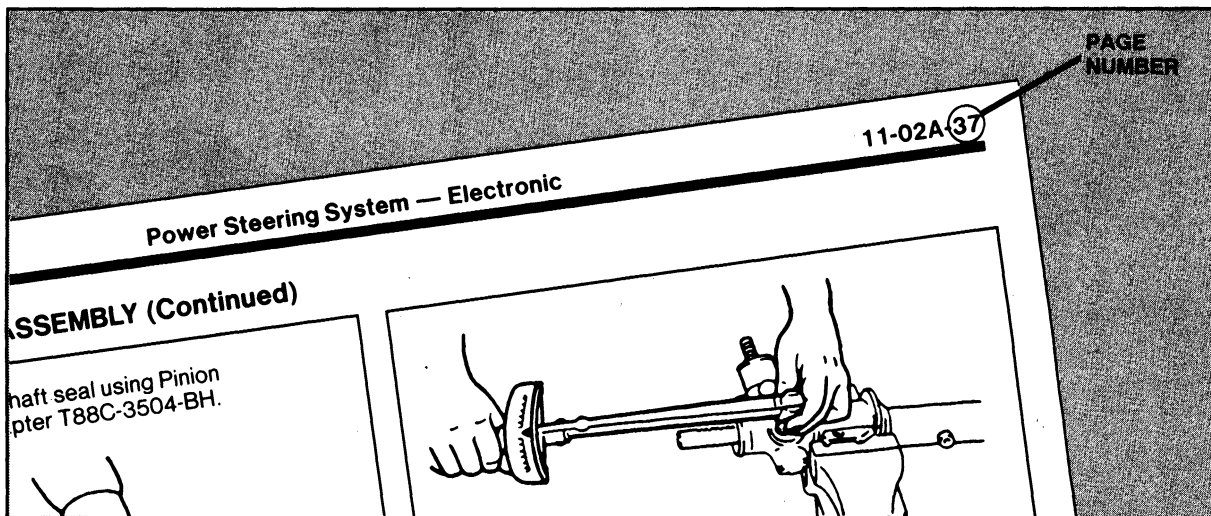


To assist in locating a subject, whenever feasible, Section titles have the subject first, followed by a descriptive word(s).

- Mirrors – Rearview
- Mirrors – Power

Page

The third set of numbers indicate the Page in each Section.



How to Find Material in This Manual

1. Locate the Group number in the Table of Contents. **If you are not sure which Section contains the information you need, look up the component/system in the alphabetical index located in the back of this manual.**
2. Locate the Section number by using the Group index located at the beginning of each Group.
3. Locate the specific Page by using the Section index at the beginning of each Section.

How to Use Each Section

Each Section has a standard organization that consists of the following information:

Vehicle Application

Identifies the product (vehicle, model, engine, transmission, etc.) that the section applies to:

- Probe GT
- Aerostar and Ranger with integral carrier and 7.5 ring gear

Description and Operation

Describes how the component or system works.

Diagnosis and Testing

Identifies how to pinpoint problems.

Removal and Installation

Describes how to remove and reinstall components and systems.

Disassembly and Assembly

Lists how to take apart the component/system, and put it back together.

Adjustments

Describes how to perform in-vehicle adjustments.

Specifications

Summarizes all the specifications used in the Section.

Special Service Tools/Equipment

Lists all the Special Service Tools and Rotunda Equipment used in the Section.

Additional headings such as General Service Procedures and Cleaning and Inspection may be used.

What's New in This Manual

You will notice that changes have been made to some of the standard terminology that was found in past Service Manuals. Changes in state or federal law have mandated terminology changes. Please refer to the J1930 Terminology List that is located in the back of this manual.

One additional feature found in this manual is the footer located at the bottom of each page. This footer denotes the vehicle model year, carline, and Service Manual print date. If a page is accidentally separated from the manual, the footer will help you determine its proper location.

What to Do if You Discover an Error

If you discover a questionable procedure or if you have any suggestions for improving this manual, please use one of the feedback forms provided in the front and back of this manual. Your feedback is very important to improving Ford technical publications. You will get a response to your concern. If necessary, a revision will be issued.

NOTE: The descriptions and specifications contained in this manual were in effect at the time this manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications or design without notice and without incurring any obligation.

GENERAL INFORMATION

GROUP 00

SECTION TITLE	PAGE	SECTION TITLE	PAGE
IDENTIFICATION CODES	00-01-1	MAINTENANCE AND LUBRICATION.....	00-03-1

SECTION 00-01 Identification Codes

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	00-01-1	GENERAL INFORMATION.....	00-01-1

VEHICLE APPLICATION

F-250-350 and F-Super Duty Series Equipped with
7.3L Indirect Injection (IDI) Turbo Diesel Engine

GENERAL INFORMATION

For procedures or information not unique to 7.3L IDI Turbo Diesel Engine refer to the following pages in Section 00-01 in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Body/Chassis Manual:

SUBJECT	PAGE
GENERAL INFORMATION	
Build Date Stamp Locations.....	00-01-5
Vehicle Data	00-01-5
Vehicle Identification Number (VIN)	00-01-4
Vehicle Safety Compliance Certification Label	00-01-1
VEHICLE APPLICATION	00-01-1

GENERAL INFORMATION (Continued)

ENGINE TYPE, DISPLACEMENT, CYLINDERS,
FUEL TYPE, AND MANUFACTURER
(VIN POSITION 8)

1 F T E F 2 5 **C** 5 P L A 0 0 0 0 1

VIN CODE	DISPLACEMENT		CYLINDERS	FUEL	MANUFACTURER
	LITER	CID			
Y	4.9	300	I-6	GASOLINE	FORD
N	5.0	302	V-8	GASOLINE	FORD
H	5.8	351	V-8	GASOLINE	FORD
R	5.8	351	V-8	GASOLINE	FORD
G	7.5	460	V-8	GASOLINE	FORD
M	7.3	445	V-8	DIESEL	NAVISTAR
C	7.3 IDI TURBO	445	V-8	DIESEL	NAVISTAR

CY5193-A

SECTION 00-03 Maintenance and Lubrication

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	00-03-1	MAINTENANCE	00-03-1

VEHICLE APPLICATION

F-250-350 and F-Super Duty with 7.3L IDI Turbo Diesel Engines Vehicles

MAINTENANCE

For maintenance information not unique to the 7.3L IDI Turbo Diesel Engine, refer to the following pages in section 00-03 in the 1993 Econoline / F 150, F-250, F350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual:

SUBJECT	PAGE
MAINTENANCE	
Lubrication.....	00-03-14
Maintenance Schedules.....	00-03-4
Owner Maintenance Checks	00-03-12
Scheduled Maintenance, Emissions	00-03-1
SPECIFICATIONS	00-03-28

The 7.3L IDI turbo diesel engine uses a new air filter specific to the turbo engine requirements.

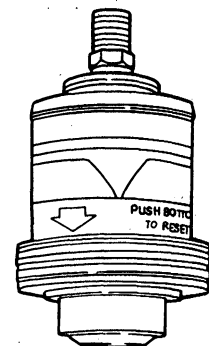
CAUTION: Use of an incorrect air filter will shorten the service life of the air filter or may cause damage to engine components.

The 7.3L IDI turbo diesel engine also has a new air restriction gauge. The restriction gauge shows if the air cleaner is restricted. The air cleaner should be replaced when the restriction gauge, the yellow band, latches into a yellow / red position. Engine performance and fuel economy are adversely affected when maximum restriction is reached. After servicing the air cleaner the restriction gauge can be re-set by pushing the button on the end of the gauge. The restriction gauge is located on the clean-air side of the air cleaner upper housing.

Gauge, Air Cleaner Restriction



REPLACE FILTER

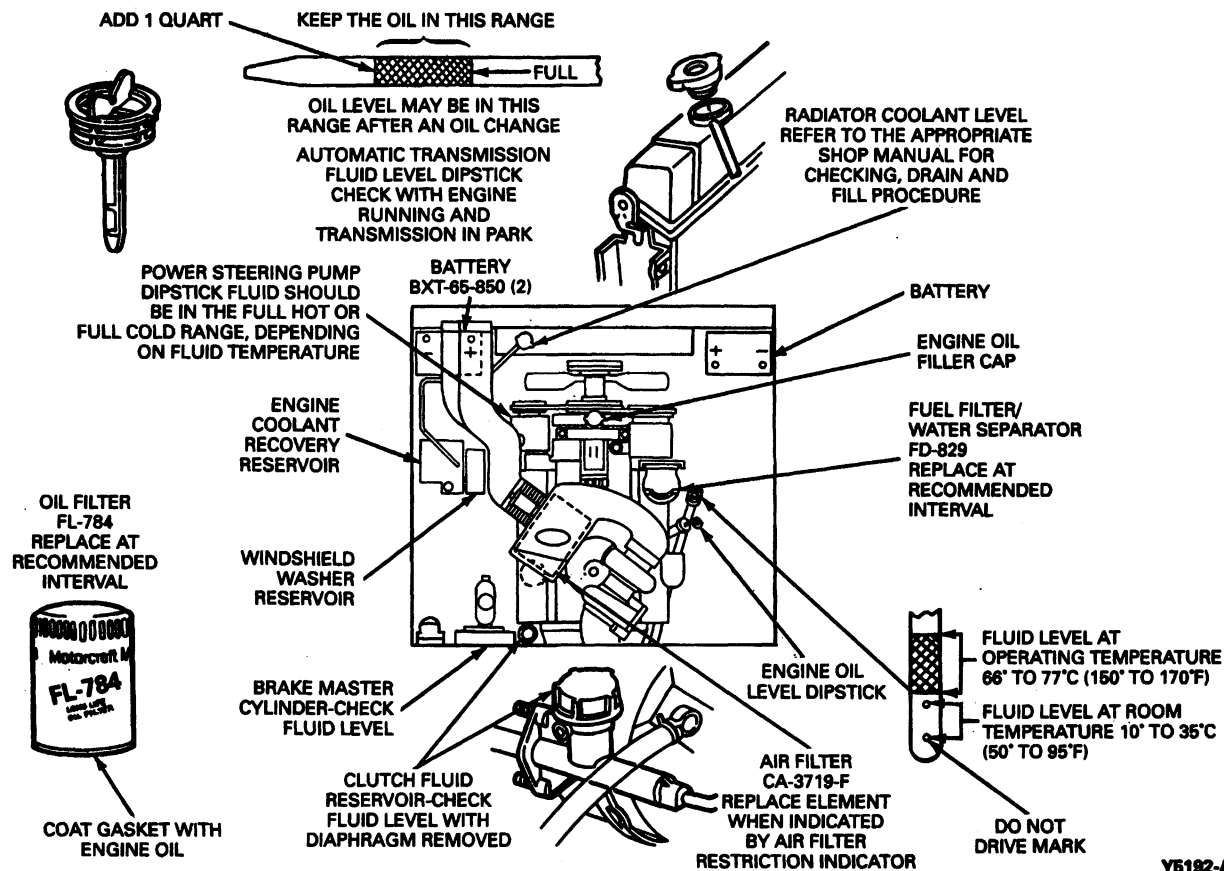


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MAINTENANCE (Continued)

Service Points, 7.3L IDI Turbo Diesel Engine, F-Series



Y5192-A

GROUP

BODY 01

SECTION TITLE	PAGE	SECTION TITLE	PAGE
BUMPERS	01-19-1	TRIM, EXTERIOR	01-08B-1

SECTION 01-08B Trim, Exterior

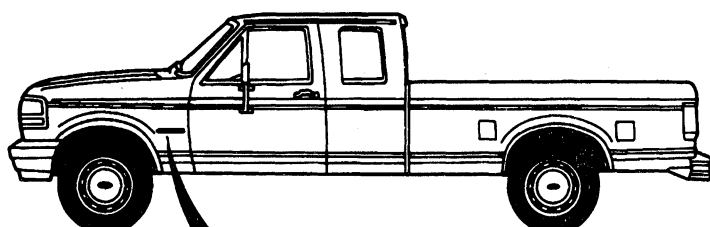
SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	01-08B-1	DESCRIPTION	01-08B-1

VEHICLE APPLICATION

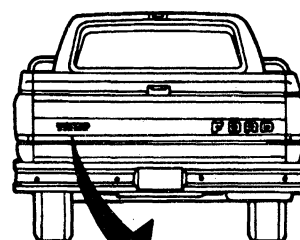
F-250, F-350 and F-Super Duty Vehicles Equipped
with 7.3L IDI Turbo Diesel Engine

DESCRIPTION

Emblem, 7.3L IDI Turbo Diesel Engine



TURBO DIESEL



**TURBO
DIESEL**

N11155-A



SECTION 01-19 Bumpers

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	01-19-1	REMOVAL AND INSTALLATION	01-19-1
DESCRIPTION	01-19-1	SPECIFICATIONS	01-19-3

VEHICLE APPLICATION

All F-250-350 and F-Super Duty Series Vehicles
Equipped with 7.3L IDI Turbo Diesel Engine

DESCRIPTION

For procedures not unique to 7.3L IDI Turbo Diesel Engine refer to the following pages in Section 01-19 in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Body / Chassis Manual:

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
Arm, Rear, Bumper-to-Frame.....	01-19-9
Bumper Bar, Front	01-19-3

(Continued)

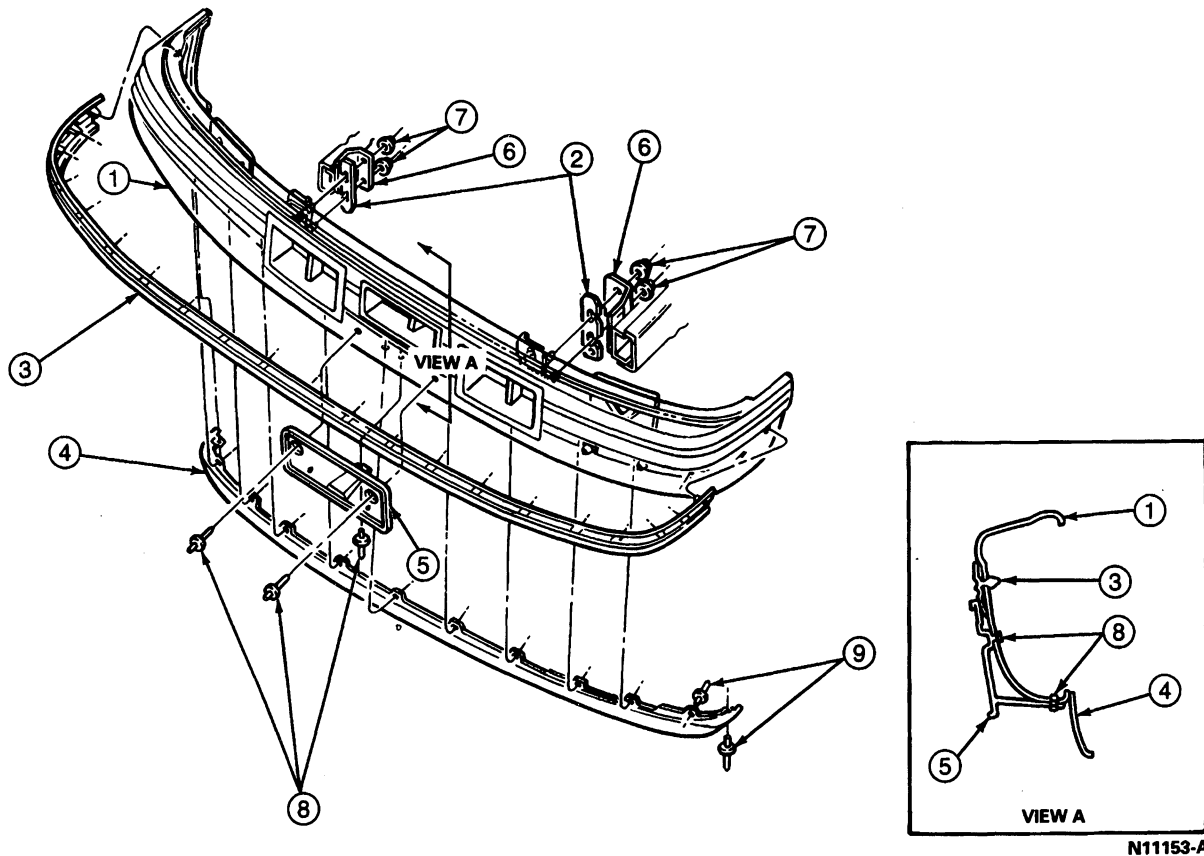
SUBJECT	PAGE
Front Valence Panel	01-19-4
Inboard Mounting Bracket	01-19-3
License Plate Bracket, Front.....	01-19-5
Outboard Mounting Bracket	01-19-3
Rear Bumper License Plate Lamps.....	01-19-8
Rear Bumper.....	01-19-5
Rear Bumper, Reinforcement	01-19-8
Rubstrip	01-19-4
SPECIFICATIONS	01-19-9

REMOVAL AND INSTALLATION

Refer to the following illustration.

REMOVAL AND INSTALLATION (Continued)

Front Bumper, F-250-350, F-Super Duty



N11153-A

Item	Part Number	Description
1	17757	Front Bumper
2	17D899 or 17A923	Front Bumper Spacer
3	17C881	Front Bumper Pad
4	17626	Front Valance Panel

(Continued)

Item	Part Number	Description
5	17A385	Front License Plate Mounting Bracket
6	Ref.	Frame
7	N804525-S59	Nut 88-118 N-m (65-87 Ft-Lb)
8	N803043-S	Rivet (3 Req'd)
9	388442-S54	Rivet (12 Req'd)

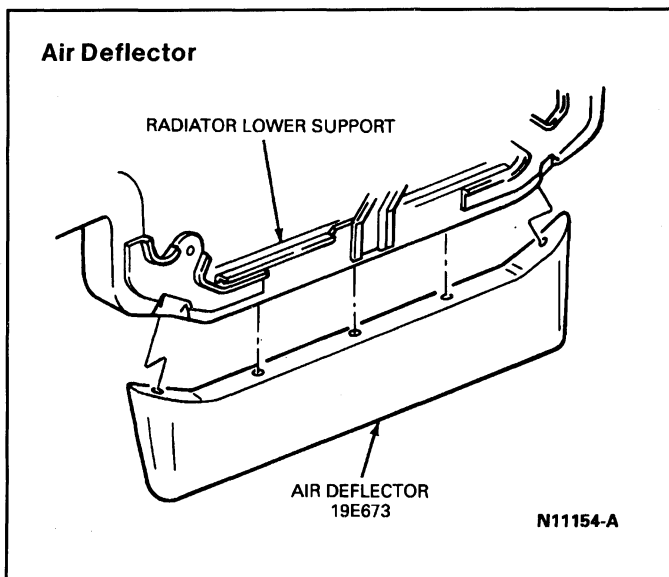
Air Deflector**Removal and Installation**

1. Remove eight rivets attaching the air deflector to the radiator support.

2. Remove the air deflector.

For installation, follow procedures in reverse order.

REMOVAL AND INSTALLATION (Continued)



Item	Part Number	Description
1	19E673	Air Deflector
2	—	Radiator Support

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
Front Bumper Nuts, F-Series, F-Super Duty	88-118	65-87

ENGINE TRANSMISSION MOUNTING

GROUP 02

SECTION 02-03 Engine/Transmission Mounting

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	02-03-1	REMOVAL AND INSTALLATION	
DESCRIPTION AND OPERATION	02-03-1	Engine Supports	02-03-1

VEHICLE APPLICATION

F-250-350 and F-Super Duty Vehicles with 7.3L IDI Turbo Diesel Engines

DESCRIPTION AND OPERATION

For procedures not unique to the 7.3L IDI turbo diesel engine refer to the following pages in section 02-03 in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual:

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
Engine Supports	02-03-1
VEHICLE APPLICATION	02-03-1

REMOVAL AND INSTALLATION

Engine Supports

Removal

1. Remove air cleaner assembly, refer to Section 03-12 Air Intake in this Supplement.
2. Remove turbocharger assembly, refer to Section 03-12B Turbocharger, 7.3L IDI Turbo Diesel V8 Engine in this Supplement.
3. Remove the rubber overflow tube from the coolant recovery bottle and detach it from the shroud (where appropriate).
4. Remove the fan shroud attaching screws and lift the shroud back and drape it onto the fan.

5. Support the engine using a wood block and a jack placed under the oil pan.
6. Remove the nuts and washers attaching the insulators to the crossmember brackets. Lift the engine sufficiently to disengage the insulator stud from the crossmember engine bracket(s).
7. Remove insulator-to-engine or engine bracket attaching nut and washer assembly. Remove engine mount.

Installation

1. Install the engine mount to the engine.
2. Install the engine mount to engine bolt and tighten to 102-129 N·m (75-95 ft-lb).

REMOVAL AND INSTALLATION (Continued)

3. Lower the engine until the insulator stud engages in the slot / hole of crossmember bracket. Install attaching nuts and tighten to 96-127 N·m (71-94 ft-lb).
4. Remove the jack and wood block from the engine oil pan.
5. Position the fan shroud to the radiator and install the fan shroud attaching screws and tighten to 6-8 N·m (53-71 in-lb).

6. Install the rubber overflow tube to the coolant recovery bottle and attach it to the shroud (where appropriate).
7. Install turbocharger assembly, refer to Section 03-12B Turbocharger, 7.3L IDI Turbo Diesel / V8 Engine in this Supplement.
8. Install air cleaner assembly, refer to Section 03-12 Air Intake in this Supplement.

GROUP

03

ENGINE

SECTION TITLE	PAGE	SECTION TITLE	PAGE
AIR INTAKE	03-12-1	TURBOCHARGER, 7.3L IDI TURBO DIESEL	
DIESEL ENGINE, 7.3L IDI TURBO V-8	03-01D-1	ENGINE	03-12B-1
ENGINE COOLING	03-03-1		

SECTION 03-01D Diesel Engine, 7.3L IDI Turbo V-8

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	03-01D-2	REMOVAL AND INSTALLATION (Cont'd.)	
DESCRIPTION AND OPERATION		Engine Oil Filter	03-01D-58
Cooling System	03-01D-7	Exhaust Manifolds	03-01D-54
Dual Mass Flywheel (Manual Transmission		Flywheel Ring Gear (Dual Mass Flywheel	
Only)	03-01D-19	Only)	03-01D-38
Engine Components	03-01D-10	Flywheel, Engine Rear Cover and Oil	
Engine Description	03-01D-2	Seal	03-01D-36
Fuel Filter / Fuel Heater / Water		Front Crankshaft Oil Seal, In-Vehicle	
Separator	03-01D-18	Replacement	03-01D-32
Fuel System	03-01D-15	Fuel Supply Pump	03-01D-46
Glow Plug Fast Start System	03-01D-18	Injection Nozzle Fuel Lines	03-01D-50
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Vehicle and Engine Identification	03-01D-20	Injection Pump	03-01D-46
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Camshaft End Play	03-01D-26	Cover	03-01D-39
Compression Test	03-01D-23	Intake Manifold, Valley Pan and	
Crankshaft End Play	03-01D-26	Tappets	03-01D-52
Diagnostic Procedures, Engine Performance		Oil Pan, Oil Pump and Oil Pick-Up Tube	03-01D-59
and Glow Plug System	03-01D-27	Pistons and Connecting Rods	03-01D-61
Drive Gear Backlash (All Gears)	03-01D-26	Secondary Flywheel	03-01D-38
Engine Oil Leaks	03-01D-22	Thermostat	03-01D-54
Flywheel Runout, Automatic		Valve Cover, Rocker Arm, and Push Rod	03-01D-42
Transmission	03-01D-26	Valve Spring, Retainer and Stem Seal	03-01D-43
Flywheel Runout, Manual Transmission	03-01D-26	Water Pump	03-01D-30
Hydraulic Valve Tappet	03-01D-24	DISASSEMBLY AND ASSEMBLY	
Oil Cooler Internal Leakage Test	03-01D-22	Cylinder Block	03-01D-73
Static (Engine Off) Valve Train Analysis	03-01D-24	Cylinder Head Assembly	03-01D-68
REMOVAL AND INSTALLATION		Oil Cooler	03-01D-75
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Camshaft Bearings	03-01D-66	ADJUSTMENTS	03-01D-75
Camshaft Drive Gear, Fuel Pump Cam, Spacer		CLEANING AND INSPECTION	
and Thrust Plate	03-01D-41	Accelerator Linkage	03-01D-84
Core Plugs	03-01D-67	Camshaft	03-01D-79
Crankcase Depression Regulator		Connecting Rods	03-01D-80
(CDR)	03-01D-42	Crankcase Depression Regulator	
Crankshaft	03-01D-63	(CDR)	03-01D-76
Crankshaft Drive Gear	03-01D-39	Crankshaft	03-01D-79
Crankshaft Vibration Damper	03-01D-31	Crankshaft Vibration Damper	03-01D-79
Cylinder Heads	03-01D-55	Cylinder Block	03-01D-83
Engine Assembly	03-01D-27	Cylinder Heads	03-01D-76
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Seal	03-01D-33	Engine Fuel Filter	03-01D-84
Engine Front Insulators	03-01D-29	Engine Oil Level	03-01D-84
Engine Oil Cooler	03-01D-58	Exhaust Manifolds	03-01D-78

SECTION 03-01D Diesel Engine, 7.3L IDI Turbo V-8

SUBJECT	PAGE	SUBJECT	PAGE
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Fuel Supply Pump	03-01D-84	Push Rods	03-01D-76
Hydraulic Valve Tappets	03-01D-78	Thermostat	03-01D-84
Intake Manifold	03-01D-78	Valve Rocker Arm Assembly	03-01D-76
Main and Connecting Rod Bearings	03-01D-80	Valves	03-01D-77
Oil Pan	03-01D-83	SPECIFICATIONS	03-01D-84
Oil Pump	03-01D-83	SPECIAL SERVICE TOOLS / EQUIPMENT	03-01D-89

VEHICLE APPLICATION

F-Series and F-Super Duty Series Vehicles Equipped with Indirect Injection (IDI) Turbo Diesel Engine

DESCRIPTION AND OPERATION

Engine Description

The 7.3L IDI turbo diesel engine is a four-cycle, forced induction V-8 with overhead valves. It displaces 7.3 liters (444 cu. in.). The right bank of cylinders are numbered 1, 3, 5, 7, with number 1 being at the front. The firing order is 1-2-7-3-4-5-6-8.

The crankcase has been specially designed to withstand the loads of turbo diesel operation. It utilizes four bolt main bearing caps to provide a strong support for the rotating parts. The crankcase also incorporates internal piston oil cooling jets which direct oil to the underside of the piston.

The crankshaft is a five main bearing unit with fore and aft thrust controlled at the center (No. 3) bearing. Heavy-duty forged steel connecting rods attach to the crankshaft, two to each bearing throw. The piston pin is a free-floating type, permitting the pin to move or float freely in piston and rod. The piston pin is retained by snap rings.

The camshaft is supported by five insert-type bearings pressed into the block. It is driven by a gear keyed to the crankshaft. Camshaft end thrust is controlled by a thrust flange located between the front camshaft journal and the thrust flange spacer.

The aluminum-alloy anodized pistons are fitted with two keystone compression rings and one oil ring.

The hydraulic valve tappets minimize engine noise and maintain zero valve lash (tappet clearance). This eliminates the need for periodic adjustment. The hydraulic valve tappets incorporate camshaft roller followers for improved camshaft wear characteristics.

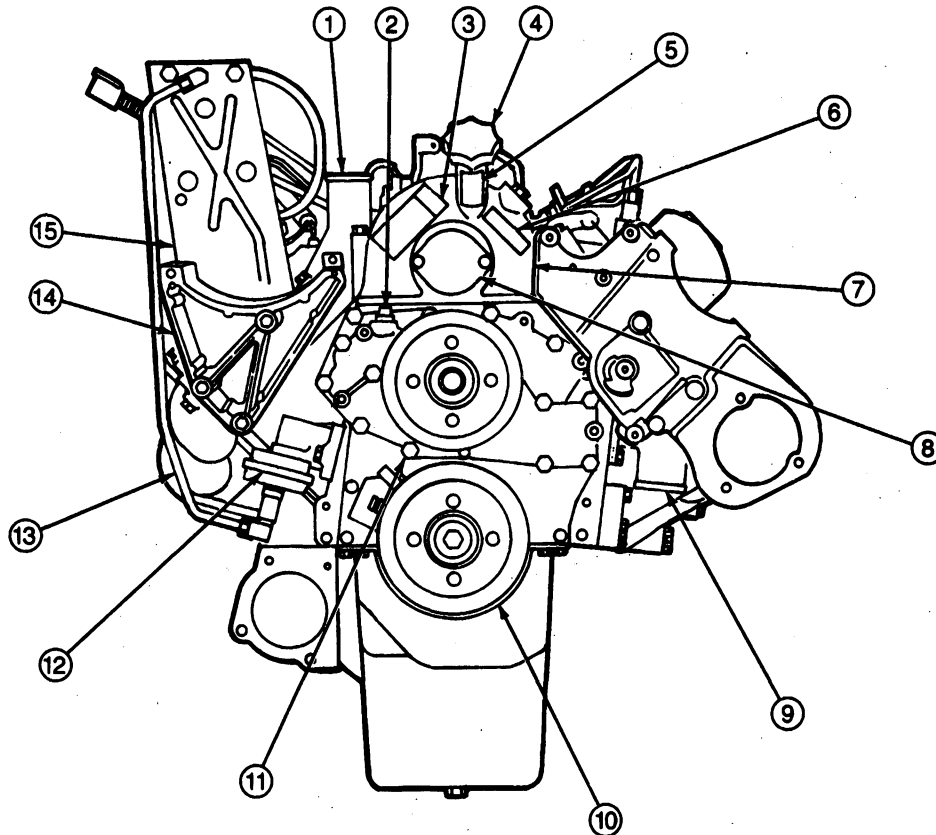
The cylinder head assemblies feature precombustion chambers which provide superior combustion characteristics. The cylinder head assemblies are equipped with positive valve-rotating mechanisms located at the bottom of the intake and exhaust valve springs.

A solid-state glow plug system and block heater provide excellent cold weather start capability.

The engine is equipped with a combination fuel filter / fuel heater / water separator. The F-Series locates the fuel filter assembly on the left side of the engine by utilizing a filter base with an integral filter bracket.

The engine is equipped with a fully closed crankcase ventilation system. Crankcase vapors are directed to the intake manifold from a port in the crankcase depression regulator (CDR) valve. It regulates crankcase pressure by providing a connection between the valve cover and the upper air cleaner housing. The crankcase depression regulator (CDR) valve is mounted on the left valve cover.

The rotary-type injection pump is located between the cylinder heads in a recess in the front of the engine. The engine governor is integral with the fuel injection pump. It is an opposed plunger, inlet metered, positive displacement, distributor type pump. Operating principles and service instructions for the fuel system components are also provided in this section.

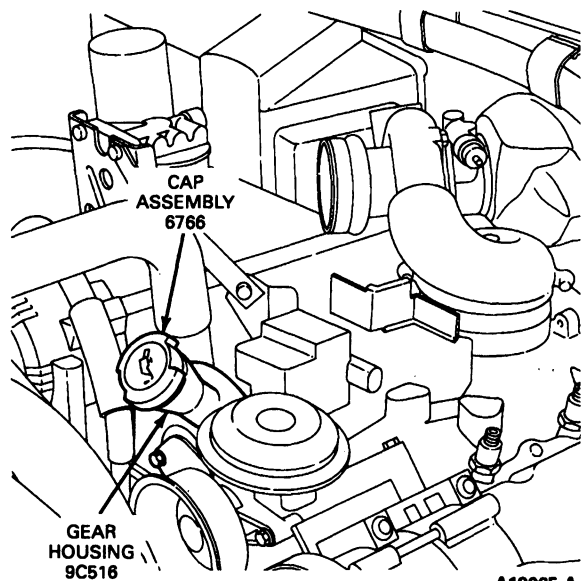
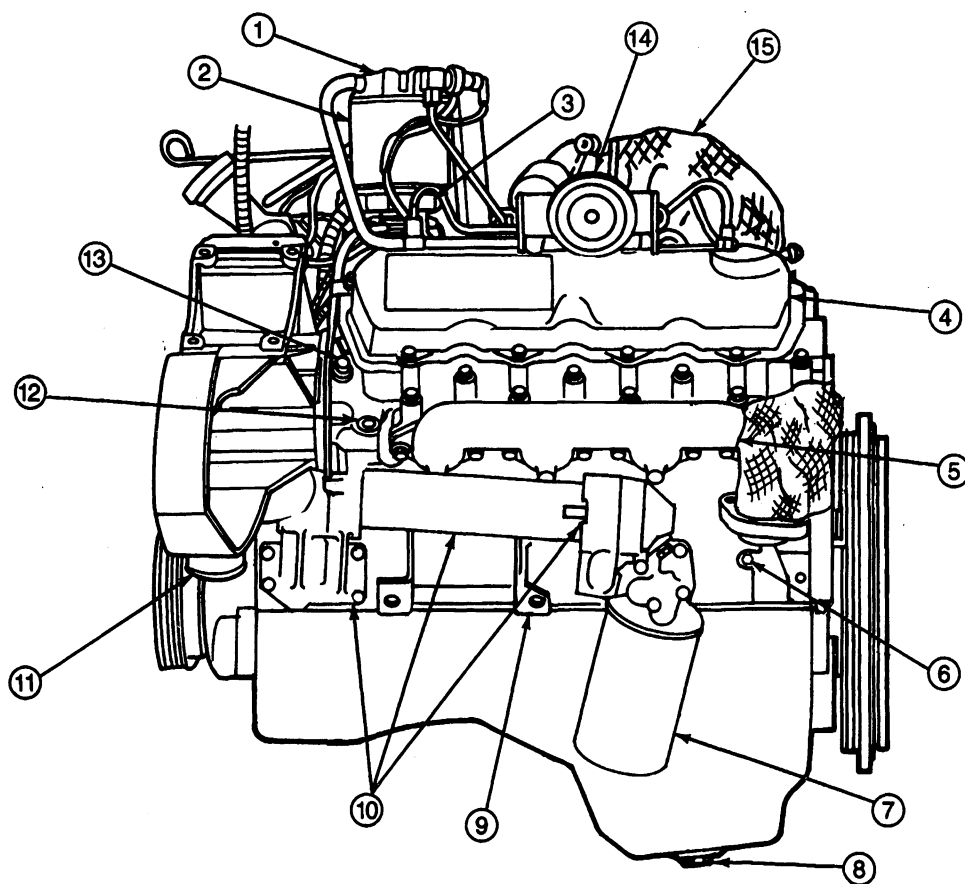
DESCRIPTION AND OPERATION (Continued)**7.3L IDI Turbo Diesel, Front View, F-Series**

A19063-A

Item	Description
1	Coolant Outlet
2	Heater Return
3	Engine Code Label
4	Oil Fill Cap
5	Oil Change Information Label
6	Serial Number Label
7	Injection Pump Gear Tower

(Continued)

Item	Description
8	Injection Pump Cover Plate
9	Coolant Inlet
10	Crankshaft Pulley
11	Water Pump Pulley
12	Fuel Supply Pump
13	Fuel Supply Pump to Fuel Filter Header
14	Alternator Bracket
15	Fuel Filter Header Mounting Bracket

DESCRIPTION AND OPERATION (Continued)**Oil Fill Tube, F-Series, 7.3L IDI Turbo Diesel****7.3L IDI Turbo Diesel, Left Side****7.3L IDI TURBO DIESEL ENGINE — LEFT HAND SIDE**

A19064-A

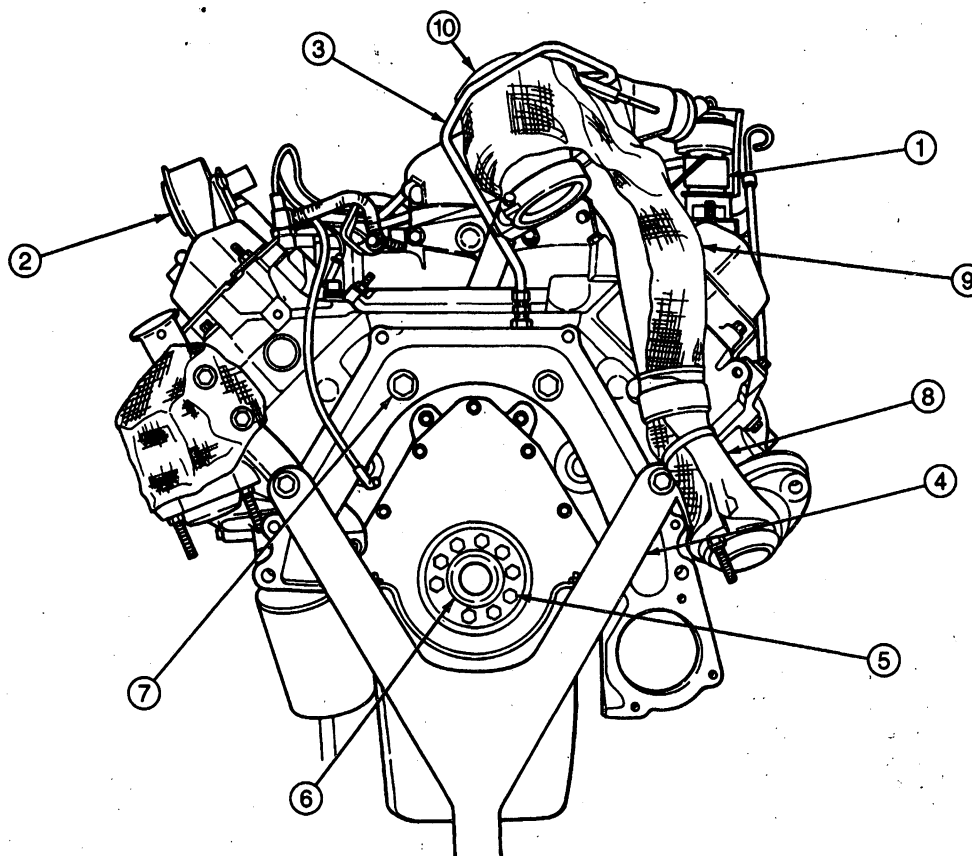
DESCRIPTION AND OPERATION (Continued)

Item	Description
1	Fuel Filter Header with Fuel Heater
2	Fuel Filter Element
3	Water Separator Drain Bowl
4	Valve Cover
5	Exhaust Manifold
6	Coolant Drain
7	Lube Oil Filter

(Continued)

Item	Description
8	Oil Drain Plug
9	Engine Mount
10	Oil Cooler Assembly
11	Coolant Inlet
12	Engine Temperature Warning Lamp Connector Location
13	Coolant Temperature Sending Unit
14	CDR Valve
15	Turbocharger Assembly

7.3L IDI Turbo Diesel, Rear View, F-Series



A19075-A

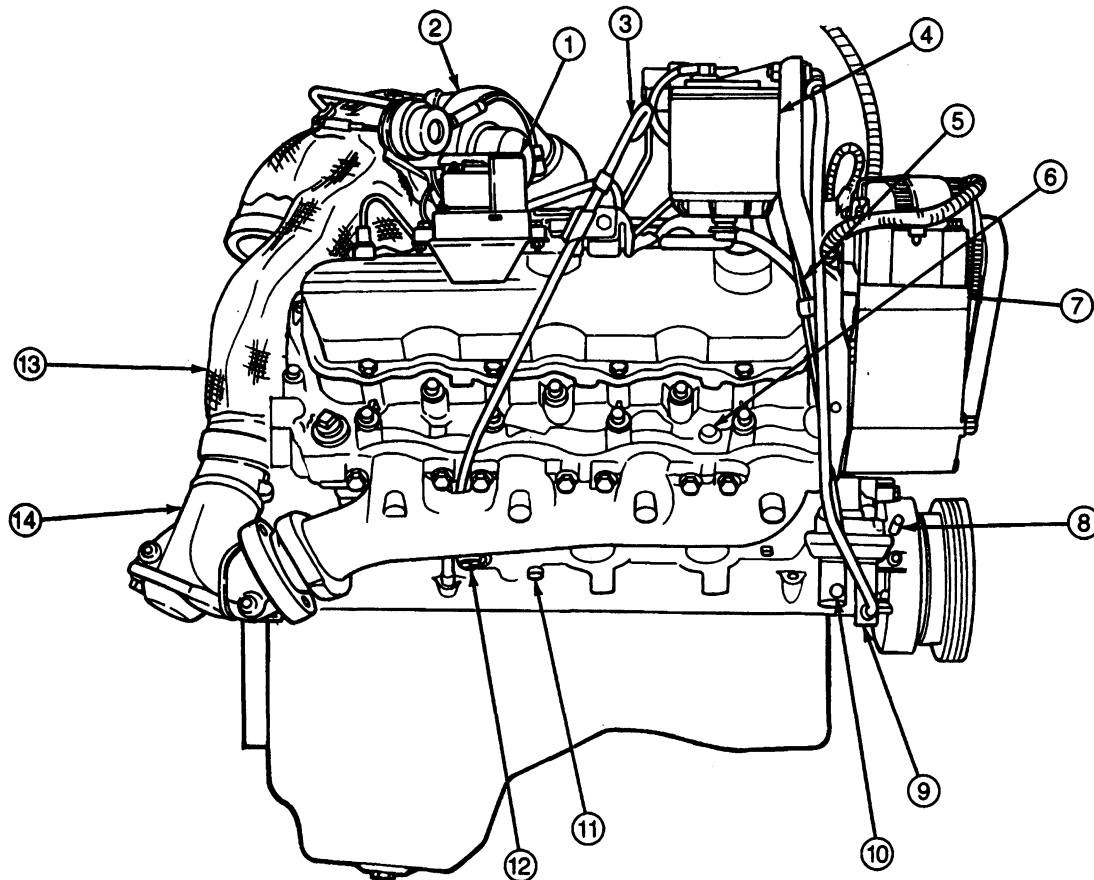
Item	Description
1	"Solid State" Glow Plug Controller
2	CDR Valve
3	Oil Feed Tube
4	Flywheel Adapter Housing
5	Flywheel Mounting Bolts

(Continued)

Item	Description
6	Reinforcement Ring (Automatic Transmission Only)
7	Adapter Housing Bolts
8	Exhaust Y-Collector
9	Turbocharger Exhaust Inlet
10	Turbocharger Assembly

DESCRIPTION AND OPERATION (Continued)

7.3L IDI Turbo Diesel, Right Side, F-Series

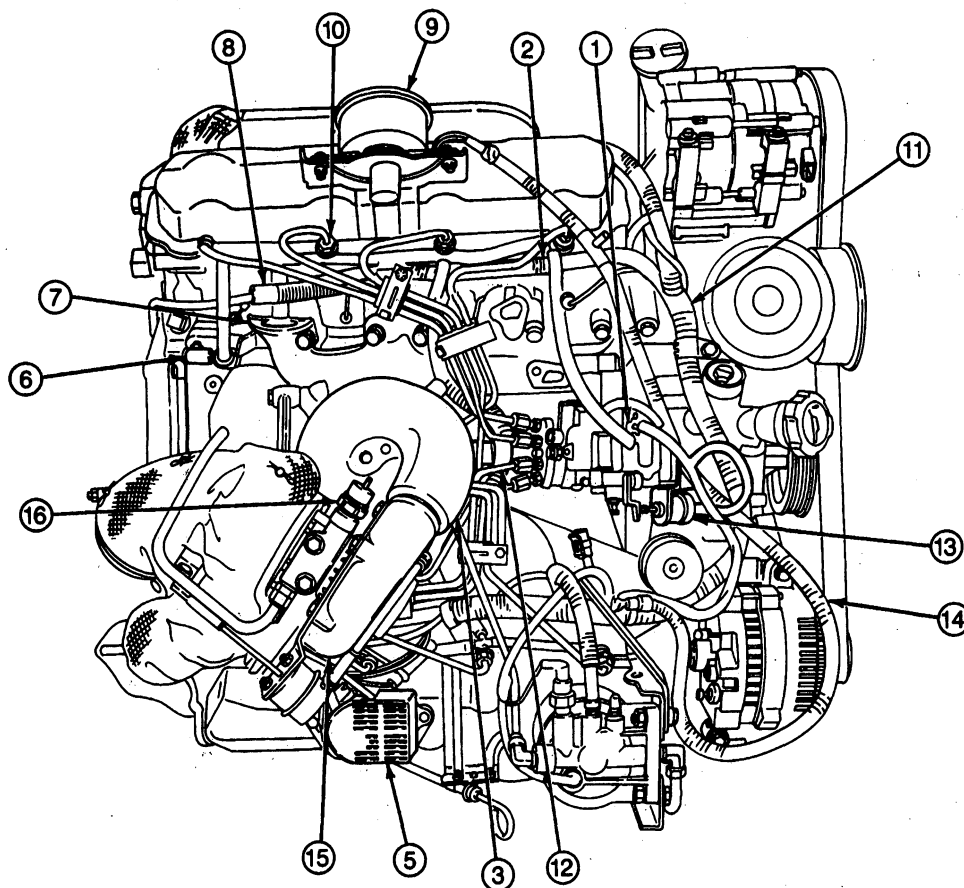


A20401-A

Item	Description
1	Glow Plug Module
2	Turbocharger Assembly
3	Oil Level Gauge
4	Combination Fuel Filter, Fuel Heater and Water Separator
5	Water Drain Tube
6	Heater Supply

(Continued)

Item	Description
7	Heater Return
8	Timing Indicator
9	Vibration Damper
10	Fuel Inlet
11	Coolant Drain
12	Crankcase Coolant Heater Location
13	Turbocharger Exhaust Inlet
14	Exhaust Y-Collector

DESCRIPTION AND OPERATION (Continued)**7.3L IDI Turbo Diesel, Top View, F-Series**

A20402A

Item	Description
1	Fuel Injection Pump
2	Glow Plug Harness
3	Air Chamber
5	Glow Plug Controller
6	Fuel Return Nipple
7	Lifting Eye (2 Places)
8	Glow Plugs (8)

(Continued)

Item	Description
9	CDR Valve
10	Injection Nozzles
11	Coolant Temperature Sensing Unit
12	High Pressure Injection Lines (8)
13	Fast Idle Solenoid
14	Heater Return
15	Turbocharger Assembly
16	Oil Pressure Sender

Cooling System

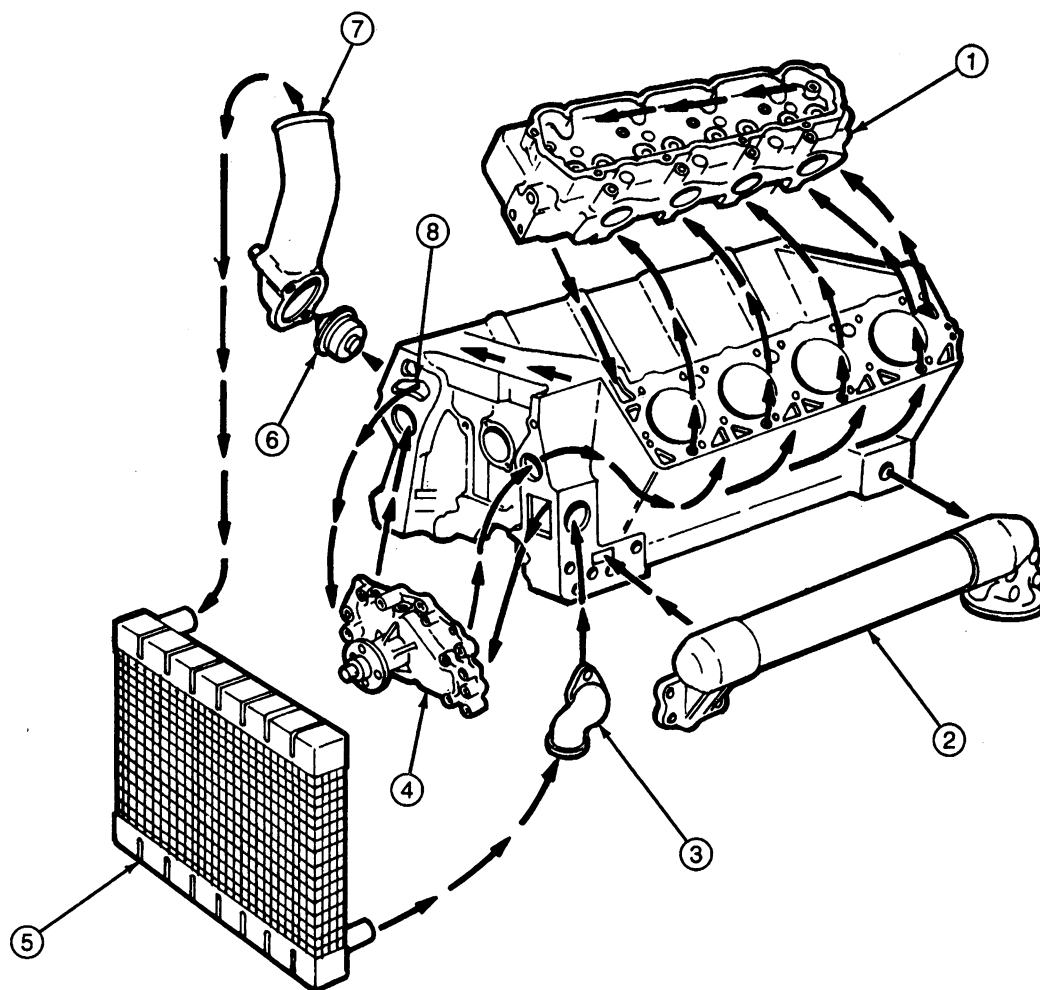
Coolant flows from the radiator, to the water pump, to the engine right and left banks.

Circulation of the coolant is from the front to the rear of the crankcase. Coolant flows from the crankcase to the cylinder head through positive cooling passages, and through one passage at the front and rear bulkhead of the cylinder head. Coolant flows between the precombustion chambers and valve seats toward the front. Coolant exits the cylinder head into a common cavity which runs across the front of the crankcase. This cavity routes coolant to the thermostat housing.

When the thermostat is closed, coolant bathes the thermostat and runs through the bypass orifice which is located below the thermostat. No coolant is allowed to enter the radiator.

DESCRIPTION AND OPERATION (Continued)

When the coolant reaches 89°C (192°F) the thermostat begins to open. At the same time, the bottom of the thermostat moves closer to the bypass opening. The volume of coolant allowed to bypass is decreased, and coolant is permitted to circulate through the radiator. The thermostat is fully open at 100°C (212°F). Refer to Section 12-02B Heater and Ventilation System, F-Series and Bronco in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Body/Chassis Manual for heater hose routing. Refer to the engine front and left side views for coolant temperature sender, heater supply, heater return, and coolant drain locations.

Coolant Flow

A20403-A

Item	Description
1	Cylinder Head
2	Oil Cooler
3	Water Inlet

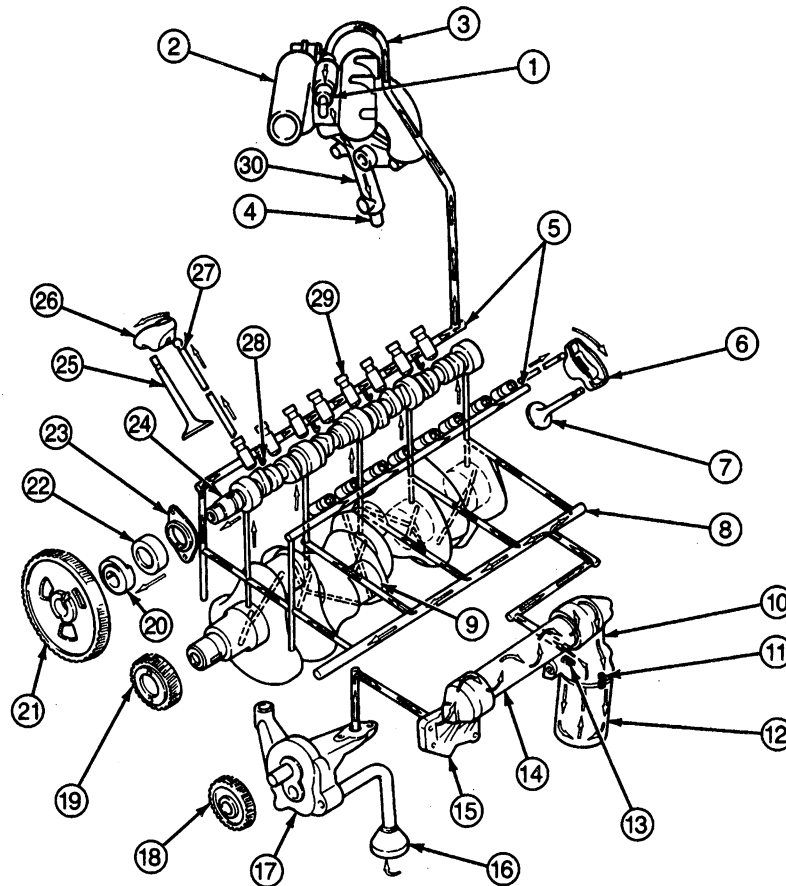
(Continued)

Item	Description
4	Water Pump
5	Radiator
6	Thermostat
7	Thermostat Housing
8	Bypass

DESCRIPTION AND OPERATION (Continued)**Lubrication System**

Lubrication oil is drawn out of the sump through the pick-up screen and oil pick-up tube to the oil pump. Oil pump flow is 45.4 liters (12 gallons) per minute at 3300 rpm and a pressure of 275-482 kPa (40-70 psi). From the oil pump, oil is passed through drilled passageways in the crankcase to the oil cooler header, then through the oil cooler. Oil flows around the outside of the heat exchanger tubes, which carry coolant. The oil passes from the oil cooler to the oil filter header. At the oil filter header, the oil pressure regulator valve controls the volume and pressure of filtered oil supplied to the engine. The rear oil filter header also incorporates a bypass valve which opens if the oil filter becomes clogged. Five cross passages distribute oil to vertical passages, which feed crankshaft main bearings, camshaft bearings and two tappet galleries. The piston cooling jets are fed from the same passage as the valve tappets. The connecting rod bearings are fed from the main bearings through drilled passages in the crankshaft. The timing gears are lubricated by oil splash. Oil passes through the hydraulic tappet rollers and up the hollow push rods to lubricate the rocker arm assemblies and valve stems.

Oil is supplied to the turbocharger from a port in the crankcase where the oil pressure sender unit was previously located. The pressurized oil is supplied to the turbine shaft bearings through external plumbing. Oil is returned to the crankcase through the cast turbocharger pedestal into the valley pan where the CDR valve was previously located.

Oil Flow

A20404-A

DESCRIPTION AND OPERATION (Continued)

Item	Description
1	Oil Pressure Sender Unit
2	Turbocharger
3	Oil Feed Tube
4	To Valley Pan
5	Cam Follower Oil Gallery
6	Rocker Arm
7	Valve
8	Main Oil Gallery
9	Connecting Rod Bearings
10	Oil Filter Header
11	Oil Filter Bypass Valve
12	Oil Filter
13	Oil Pressure Regulating Valve
14	Oil Cooler

(Continued)

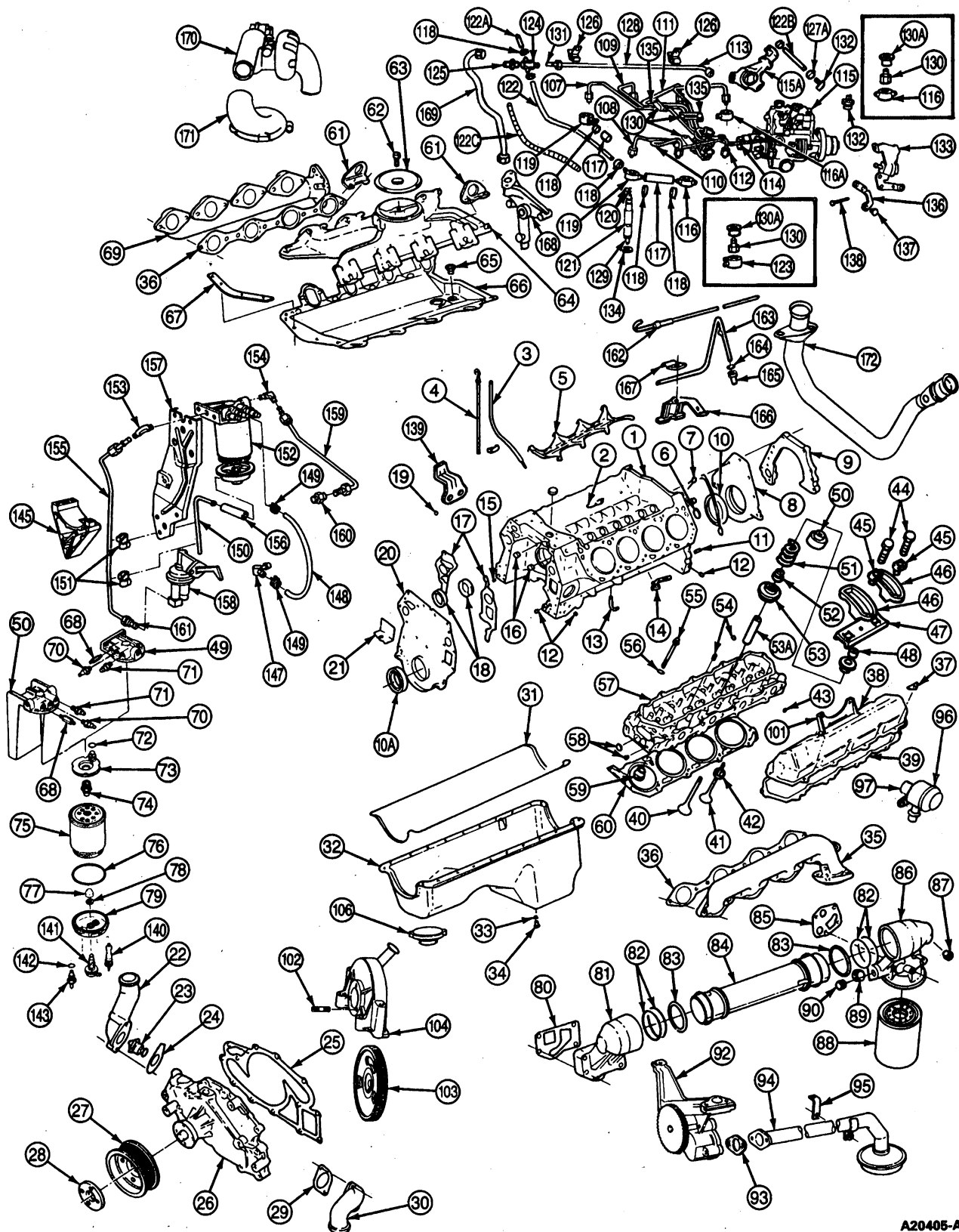
Item	Description
15	Oil Cooler Header
16	Oil Sump
17	Oil Pump
18	Oil Pump Drive Gear
19	Crankshaft Gear
20	Fuel Pump Cam
21	Camshaft Gear
22	Spacer
23	Camshaft Thrust Flange
24	Camshaft
25	Valve
26	Rocker Arm
27	Push Rod
28	Piston Cooling Jets
29	Hydraulic Roller Cam Follower
30	Oil Drain Pedestal

Engine Components

Refer to the following exploded views and indices when performing procedures in this section. Part descriptions and part numbers listed in the keys correspond with the Ford Master Parts Catalog.

DESCRIPTION AND OPERATION (Continued)

7.3L IDI Turbo Diesel, Exploded External View



A20405-A

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	6009H	Cylinder Block Assy.
2	6C329A	Guide, Tappet
3	6754	Tube Assembly, Oil Level Gauge (F-Series)
4	6750	Oil Level Gauge (F-Series)
5	6C330A	Retainer, Tappet Guide
6	6026A	Plug, Engine (1-1/2 Inch O.D.)
7	6D083A	Gasket, Rear Cover
8	6L080A	Cover Assembly, Engine, Rear
9	6A369A	Adapter, Flywheel to Transmission
10	6701A	Rear Oil Seal, Crankshaft
10A	—	Front Oil Seal
11	6B041B	Dowel Pin, Fly Wheel Adapter
12	87614S	Pipe Plug, 1/8 NPTF
13	6C327A	Piston Cooling Jet
14	6A051A	Heater Assembly, Block
15	6B041A	Dowel Pin, Front Cover Plate
16	6026E	Cup Plug
17	6020A	Gasket, Front Cover Plate
18	6A251A	Bearing Kit, Camshaft
19	6A628A	Ball, Oil Indicator Hole 11/32 Inch
20	6B070A	Plate, Front Cover
21	—	Indicator, Timing (Part of Front Cover)
22	8592G	Connection, Water Outlet
23	8575	Thermostat
24	8255A	Gasket, Water Outlet
25	8507A	Gasket, Water Pump
26	8501D	Water Pump
27	8509D	Pulley, Water Pump
28	8546A	Spacer, Fan
29	8255A	Gasket, Water Inlet
30	8592D	Connection, Water Inlet
31	D6AZ-19562-A	RTV Sealant
32	6675C	Oil Pan
33	6734A	Gasket, Oil Pan Drain
34	6730A	Plug, Oil Pan Drain
35	9431B	Manifold, Exhaust, Left
36	9448A	Gasket Exhaust Manifold
37	6A532A	Washer, Valve Cover
38	6582C	Valve Cover
39	6584A	Gasket, Valve Cover
40	6507D	Valve, Intake (8)
41	6505	Valve, Exhaust
42	6057B	Insert, Exhaust Valve Seat
43	6026F	Plug, Ball Type 13/32 Inch (8)
44	—	Bolt, Valve Lever and Washer
45	—	Post, Valve Lever
46	—	Lever, Valve
47	—	Retainer, Valve Lever Post

(Continued)

Item	Part Number	Description
48	—	Lock, Valve Spring Retainer
49	6514A	Retainer, Valve Spring (36)
50	—	Shield, Oil (Exhaust)
51	6513B	Spring, Valve, with Damper (16)
52	6571A	Seal, Valve Stem-Intake (8)
53	6K533A	Rotator, Assembly Valve (16)
53A	—	Guide, Valve (Service)
54	—	Plug, 1/2 Inch NPTF (4)
55	6065A	Bolt Cylinder Head (34)
56	6L015A	Washer, Cylinder Head Bolt (34)
57	6049A	Cylinder Head Assembly (2)
58	6026B	Plug, 1/4 Inch
59	6057A	Insert, Combustion Chamber (8)
60	6051B	Gasket, Cylinder Head (2)
61	—	Eye, Lifting (3)
62	9C629A	Insert, Bolt Thread-Air Cleaner Stud
63	9F460A	Screen, Intake Manifold
64	9424B	Manifold, Intake
65	9A450A	Drain Plug, Valley Pan
66	9439B	Gasket and Valley Pan
67	9B470A	Strap, Valley Pan
68	—	Fuel Priming Valve and Cap
69	9430A	Manifold, Exhaust, Right
70	—	Continuous Vent with Check Valve
71	—	Vacuum Switch (Fuel Filter Element Replacement Indicator)
72	—	Fuel Heater O-Ring
73	—	Fuel Heater
74	—	Threaded Insert
75	—	Fuel Filter Element
76	—	Drain Bowl O-Ring
77	—	Drain Valve Stem Cap
78	—	Drain Valve Seal
79	—	Water Separator Drain Bowl
80	6A636A	Gasket, Oil Cooler, Front Header
81	—	Header, Oil Cooler, Front
82	6K649A	O-Ring, Oil Cooler (2)
83	6C610A	O-Ring, Oil Cooler (2)
84	6A642A	Cooler, Oil
85	6A636B	Gasket, Oil Cooler, Rear Header
86	6881B	Header, Oil Cooler, Rear
87	6K862A	Plug, 1/4 Inch
88	6731A	Oil Filter
89	—	Plug, 1/2 Inch
90	—	Plug, 1/2 Inch
92	6600	Oil Pump Assy.
93	6626	Gasket, Oil Pick-Up
94	6622	Pick-Up Tube

(Continued)

DESCRIPTION AND OPERATION (Continued)

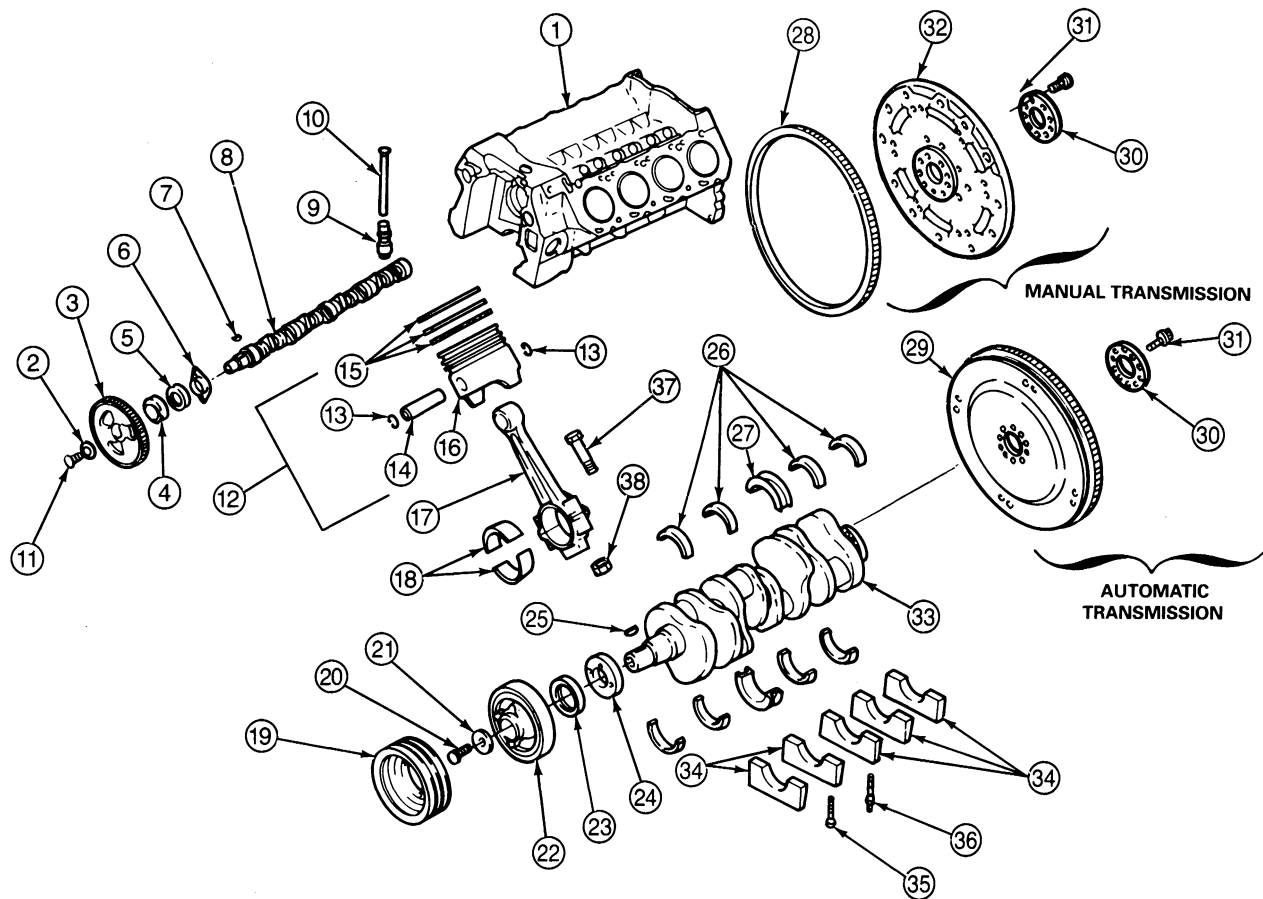
Item	Part Number	Description
95	6A661	Bracket, Oil Pick-Up
96	6A665	CDR Valve
97	6A892	Seal Ring, CDR Valve
100	6758	Crankcase Vent Tube
101	6769	Grommet, Valley Cover
102	9F733	Mounting Stud, Injection Pump
103	9A546	Drive Gear, Injection Pump
104	9C516	Adapter Housing, Injection Pump
106	6766	Cap, Oil Filter
107	9A555H	Pipe w/ Nuts Pump to Cyl. 8
108	9A555G	Pipe w/ Nuts Pump to Cyl. 7
109	9A555F	Pipe w/ Nuts Pump to Cyl. 6
110	9A555E	Pipe w/ Nuts Pump to Cyl. 5
111	9A555D	Pipe w/ Nuts Pump to Cyl. 4
112	9A555C	Pipe w/ Nuts Pump to Cyl. 3
113	9A555B	Pipe w/ Nuts Pump to Cyl. 2
114	9A555A	Pipe w/ Nuts Pump to Cyl. 1
115	9A543	Injection Pump
115A	—	Valve, Vacuum Modulator (Auto. Trans.)
116	—	Fuel Return Tee
116A	—	Elbow, Fuel Return (F-Series)
117	—	Hose
118	9B255	Clip
119	9A564	Fuel Return Tee
120	87032-S92	O-Rings
121	9E527	Injection Nozzle Holder
122	—	Fuel Return Hose
122A	—	Hose
122B	—	Hose, Pump to Fuel Return Tube
122C	—	Guard, Rear Fuel Return Hose
123	—	Fuel Return Tee (E-Series)
124	9F734	Fuel Return Junction Fitting
125	—	Nipple, Fuel Return
126	9N659	Clamp
127	9F736	Elbow
127A	—	Clip
128	9D308	Tube
129	—	Nozzle Tip
130	—	Sensor, Fuel Line Pressure
130A	—	Cover
131	9C387	Sleeve Seal, Fuel Return (2)
132	9E939	Temperature Switch
133	12B526	Bracket and Solenoid-Fast Idle
134	—	Gasket Nozzle (8)
135	9N653	Clamp

(Continued)

Item	Part Number	Description
136	9F541	Kickdown Lever (Auto. Trans.)
137	9D927	Screw, Kickdown Lever
138	9F539	Adjusting Screw (Kickdown Lever)
139	6786	Bracket, Oil Level Tube Support (F-Series)
140	—	Vent / Valve Assembly
141	—	Manual Drain Valve
142	—	Water Sensor O-Ring
143	—	Water Sensor Probe
144	—	Fuel Pump Supply Gasket
145	—	Alternator Bracket
146	—	Sealing O-Ring
147	—	Fuel Return Tee (At Nozzle)
148	—	Hose, 3/ 16 Inch ID x 10 Inch Long
149	—	Hose Clip
150	—	Water Drain Tube
151	—	Drain Tube Clamp (Z)
152	—	Fuel Filter / Water Separator Element
153	—	Elbow
154	—	Elbow, Fuel Supply Pump to Filter Header
155	—	Fuel Pump to Fuel Header Tube (With Two Nuts and Two Sleeves)
156	—	Hose, 3/ 16 Inch x 2-5/ 16 Inch Long
157	—	Fuel Filter Header Mounting Bracket
158	—	Fuel Supply Pump
159	—	Filter to Injection Pump Tube (With Two Nuts and Two Sleeves)
160	—	Connector Fitting
161	—	Inverted Flare Tube Nut
162	—	Oil Level Gauge — E-Series
163	—	Tube Assembly, Oil Level Gauge — E-Series
164	—	O-Ring, Oil Level Gauge — E-Series
165	—	Oil Level Gauge Tube, Lower — E-Series
166	—	Bracket, Oil Level Gauge Tube — E-Series
167	—	Retainer, Oil Level Gauge Tube — E-Series
168	—	Pedestal, Oil Drain
169	—	Tube, Oil Feed
170	—	Turbocharger Assembly
171	—	Housing, Intake Manifold (Volute)
172	—	Tube, Exhaust Crossover

DESCRIPTION AND OPERATION (Continued)

7.3L IDI Turbo Diesel, Exploded Internal View



A20406-A

Item	Part Number	Description
1	6009H	Cylinder Block Assembly
2	6278A	Washer, Camshaft
3	6256A	Gear, Camshaft
4	6287A	Eccentric, Fuel Pump
5	6265A	Spacer, Camshaft Gear
6	6269A	Camshaft Thrust Plate
7	6L269A	Key, Camshaft Alignment
8	6250B	Camshaft
9	6500A	Roller Tappet
10	6565A	Push Rod
11	6K252A	Bolt, Camshaft Drive Gear
12	6108G	Set, Piston, Pin
13	6140A	Retainer, Piston Pin
14	6135B	Piston Pin
15	6148D	Piston Rings
16	—	Piston (Not Available Separately)
17	6200A	Connecting Rod
18	6211A	Bearing Kit, Connecting Rod
19	6A312A	Pulley, Crankshaft
20	—	Bolt, Hex Head

(Continued)

Item	Part Number	Description
21	6278B	Washer, Crankshaft
22	6379A	Damper, Crankshaft
23	6700A	Seal, Crankshaft Front Oil
24	6306A	Gear, Crankshaft Drive
25	6B316A	Key, Crankshaft Alignment
26	6333A	Bearing, Crankshaft
27	6337A	Bearing, Crankshaft Thrust
28	6384A	Ring Gear, Flywheel — Manual Transmission
29	—	Flywheel — Automatic Transmission
30	—	Reinforcement Ring
31	6379A	Bolt, Flywheel to Crankshaft
32	6477	Flywheel Dual Mass — Manual Transmission
33	6303A	Crankshaft (with Bearings)
34	—	Bearing Cap (Part of Cyl. Block Assy.)
35	6345A	Bolt, Bearing Cap
36	6345B	Stud, Bearing Cap
37	6214A	Bolt, Connecting Rod
38	6212A	Nut, Connecting Rod

DESCRIPTION AND OPERATION (Continued)

Fuel System

WARNING: USE MOTORCRAFT® FUEL FILTER/WATER SEPARATOR FD-829 OR EQUIVALENT.

Fuel from the tank is routed to the fuel supply pump through a combination fuel filter, heater and water separator. The filter header contains a continuous vent (orifice bleed-off system) which aids starting by eliminating the need to manually prime the fuel filter. A vacuum switch is incorporated into the fuel filter header which will activate an instrument panel lamp, indicating the need for filter replacement. The water separator portion of the filter assembly has a probe which activates an instrument panel lamp when the filter requires draining at the water and sediment drain (located on the bottom of the assembly).

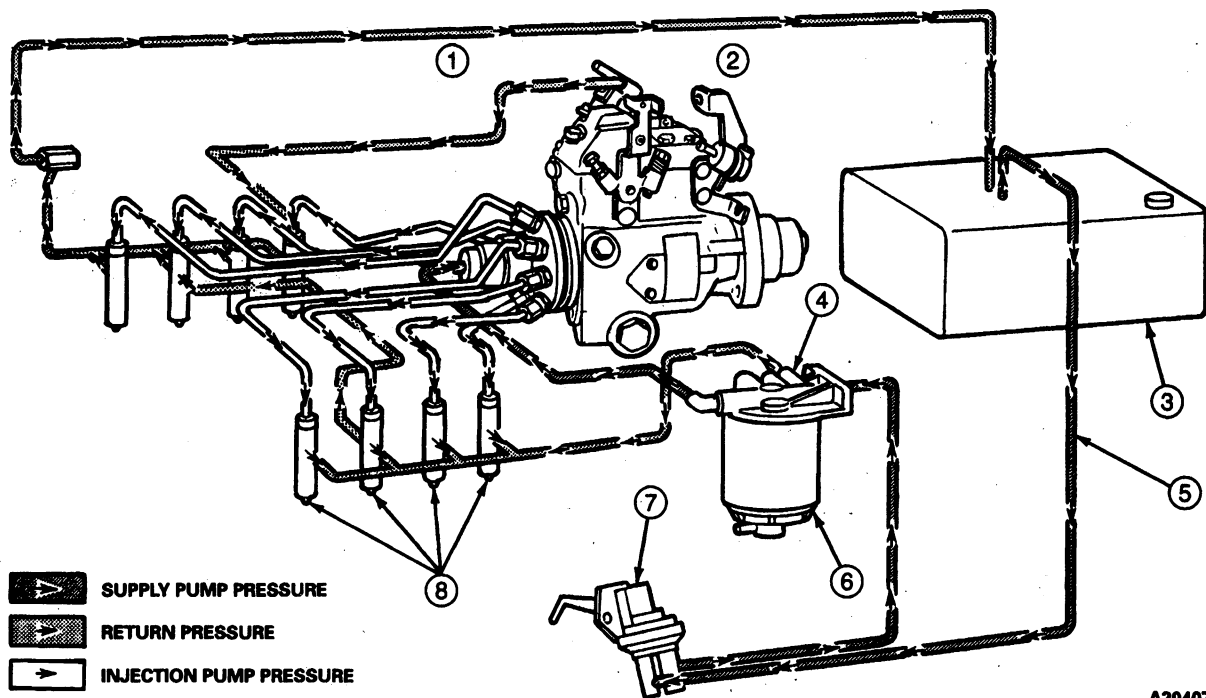
NOTE: Proper filtration of diesel fuel cannot be overemphasized. It is essential for long component life and reliability.

Fuel Flow

Fuel enters the inlet of the injection pump and is delivered under high pressure through injection nozzles into the engine cylinders for combustion. Each nozzle incorporates a fuel return fitting that returns excess fuel to the fuel tank. Excess fuel from the injection pump and each injection nozzle is collected in bleed-off lines and returned to the fuel tank.

Injection nozzles are located on the inboard side of the cylinder head. This configuration provides better access to the engine for servicing.

The fuel shutoff solenoid controls the flow of fuel into the injection pump charging circuit (high pressure). With the ignition switch in START or RUN, the solenoid is energized and fuel is allowed to flow to the injection pump charging circuit. With the ignition switch off, fuel flow to the injection pump charging circuit stops.



A20407-A

Item	Description
1	Fuel Return
2	Injection Pump
3	Fuel Tank

(Continued)

Item	Description
4	Orifice Bleed-Off
5	Fuel Supply Line
6	Fuel Filter/Heater/Water Separator
7	Fuel Supply Pump
8	Injection Nozzles

DESCRIPTION AND OPERATION (Continued)

The IDI turbo diesel injection pump is the same model used on naturally-aspirated 7.3L diesel engine, but the pump does have an increased fuel flow rate to compensate for the increased air flow. When replacing a turbo diesel fuel injection pump, make sure it is replaced with the same turbo diesel pump.

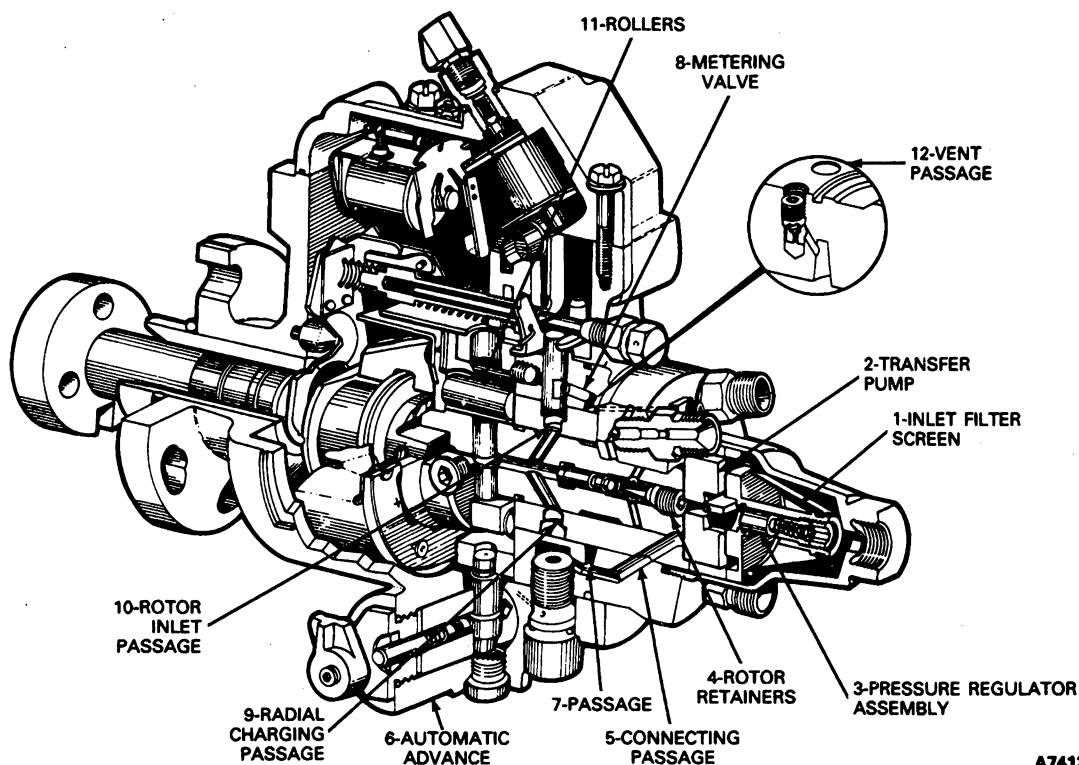
Injection Pump

The diesel fuel injection pump accurately meters and delivers fuel to a nozzle in each cylinder at high pressure and at precisely timed intervals.

Refer to following illustration for pump operating principles. Fuel flows into the injection pump inlet through an inlet filter screen (1). Fuel then flows to the vane-type transfer pump (2). Excess fuel from the transfer pump is bypassed through the pressure regulator assembly (3) to the suction side.

Fuel under transfer pump pressure flows through the center of the transfer pump rotor, past the rotor retainers (4) into the hydraulic head. It then flows through a connecting passage (5) in the head to the automatic advance (6) and up through a radial passage (7) to the metering valve (8). The position of the metering valve, controlled by a governor, regulates fuel flow into the radial charging passage (9) which incorporates the head charging ports. As the rotor revolves, the two rotor inlet passages (10) align with the charging ports in the hydraulic head, allowing fuel to flow into the pumping chamber. With further rotation, the inlet passages move out of alignment and the discharge port of the rotor aligns with one of the head outlets. While the discharge port is opened, the rollers (11) contact the cam lobes forcing the plungers together. Fuel trapped between the plungers is then pressurized and delivered by the nozzle to the combustion chamber.

In addition, an air vent passage (12) in the hydraulic head connects the outlet side of the transfer pump with the pump housing. This allows air and some fuel to be bled back to the fuel tank through the return line. Fuel bypassed in this way fills the housing, lubricates the internal components, cools and carries off any small air bubbles.

Injection Pump Internal View**A7412-28**

DESCRIPTION AND OPERATION (Continued)

Injection Nozzle Assemblies

Description

The IDI turbo diesel injection nozzles are different from the naturally-aspirated diesel engine. The nozzles have an increased flow rate over the naturally-aspirated diesel. Turbo diesel injection nozzles can be identified by a stamped code "G".

The injection nozzles are of the inwardly opening, differential, hydraulically operated, pintle-type. Their function is to direct a metered amount of fuel, under high pressure from the fuel injection pump, into the engine combustion chamber.

The injection nozzle assembly consists of two subassemblies. The nozzle holder retains the nozzle in its correct position in the cylinder head and provides channels for conducting diesel fuel to the nozzle. The nozzle consists of two parts: valve body and nozzle valve. These parts are lapped to form an extremely close-fitting matched set.

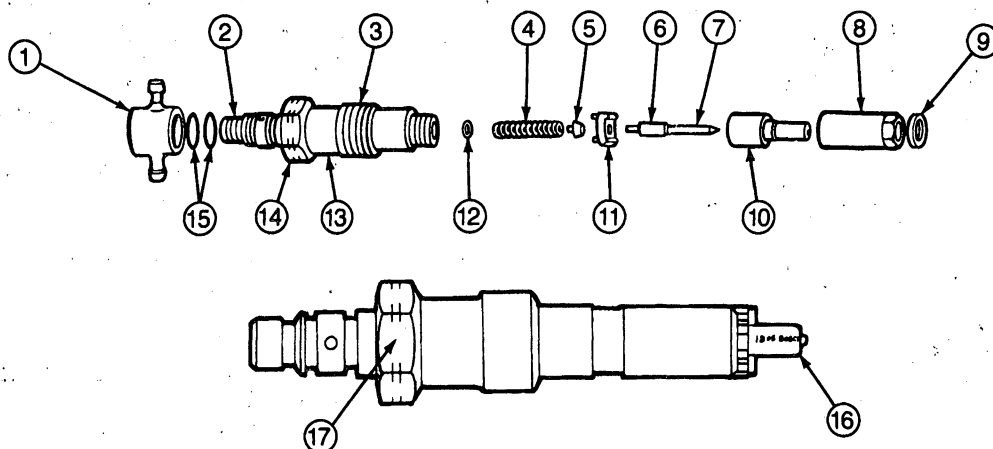
The nozzle valve carries an extension at its lower end, called the pintle.

Operation

A metered quantity of fuel passes through ducts to the pressure chamber located just above the spring seat. At the instant the pressure of fuel acting on the differential area of the valve exceeds a predetermined spring-load, it lifts the valve from its seat and fuel flows from the nozzle. Fuel cut-off occurs as the valve is seated by the nozzle spring. A small amount of fuel leakage to the spring cavity is necessary for lubrication. This fuel leakage drains through to a leak-off outlet.

Nozzle opening pressure and spray pattern should be inspected every 96,500 km (60,000 miles). Refer to Nozzle Testing in Section 20A Diesel Diagnosis, 7.3L IDI Turbo Engine in this Supplement.

Injection Nozzle and Holder Assembly



A10688-C

Item	Description
1	Fuel Return Tee (9A564)
2	High Pressure Connection
3	Nozzle Retaining Threads
4	Spring
5	Spring Seat
6	Nozzle Valve
7	Pintle
8	Nozzle Cap Nut (Retainer)

(Continued)

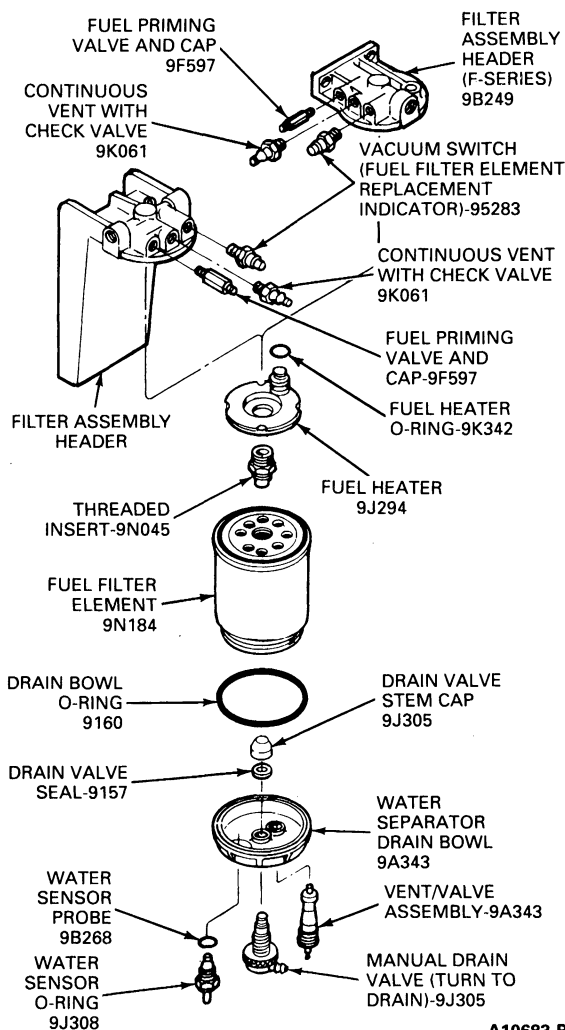
Item	Description
9	Copper Gasket (9C991)
10	Valve Body
11	Spacer With Dowels
12	Pressure Adjusting Shims
13	Nozzle Holder Body
14	Nozzle Mounting Surface
15	O-Ring Seals (9229)
16	Nozzle Tip Part Number Location
17	Stamped Code

DESCRIPTION AND OPERATION (Continued)

Fuel Filter / Fuel Heater / Water Separator

The 7.3L IDI turbo diesel engine is equipped with a fuel filter / fuel heater / water separator assembly. A WATER IN FUEL indicator lamp is provided on the instrument panel to alert the operator. The lamp should glow when the ignition switch is in the ON position to indicate proper lamp and water sensor function. If the lamp glows continuously while the engine is running, the water must be drained from the fuel filter / fuel heater / water separator manual drain valve as soon as practical to prevent damage to the fuel injection system.

Drain water from the fuel filter / fuel heater / water separator manual drain valve whenever the warning lamp comes on or every 8,046 km (5,000 miles). The WATER IN FUEL lamp will glow when approximately 103 ml (3.5 fluid ounces) of water accumulates in separator.

**Drain**

1. Stop vehicle and shut off engine.

NOTE: To avoid engine stall-out caused by air entering the fuel system, do not drain fuel / water separator while engine is running.

2. Place an appropriate container under the fuel filter / fuel heater / water separator drain tube to collect drain fluid. The drain tube is attached to the manual drain valve at base of water separator drain bowl.
3. Manually open drain valve by unscrewing. Allow drain valve to remain open approximately 15 seconds or until clear (water-free) diesel fuel flows from drain tube. Close drain valve by threading into water separator drain bowl until liquid no longer drains from drain tube.

WARNING: MAKE SURE THAT DRAIN VALVE IS FULLY AND SECURELY CLOSED.

4. Re-start the engine and check WATER IN FUEL lamp. The lamp should not glow. If it continues to glow, have fuel system checked and repaired.

Drain all traces of water from the fuel filter / fuel heater / water separator as outlined at 8,046 km (5,000 mile) intervals as specified in the maintenance schedule. At this service interval, if the warning lamp is not glowing, examine the draining fluid to determine when clear diesel fuel flows from the drain tube. Stop draining procedure as soon as clear diesel fuel appears.

Glow Plug Fast Start System

The 7.3L IDI turbo diesel engine utilizes a solid-state glow plug system to aid in the start of the engine. The system pre-heats air in the combustion chamber to aid ignition of the fuel.

The system consists of eight glow plugs (one for each cylinder), a solid-state glow plug controller / power relay assembly, two fusible links located between the power relay and the glow plug harness (one for each bank of four glow plugs), WAIT TO START lamp and a wiring harness which incorporates eight fusible wires (one for each glow plug).

CAUTION: Hard starting will result if the ignition switch is left on for over two minutes without starting the engine. If the ignition switch is turned off, it can be turned on immediately and the glow plug heating cycle will start again.

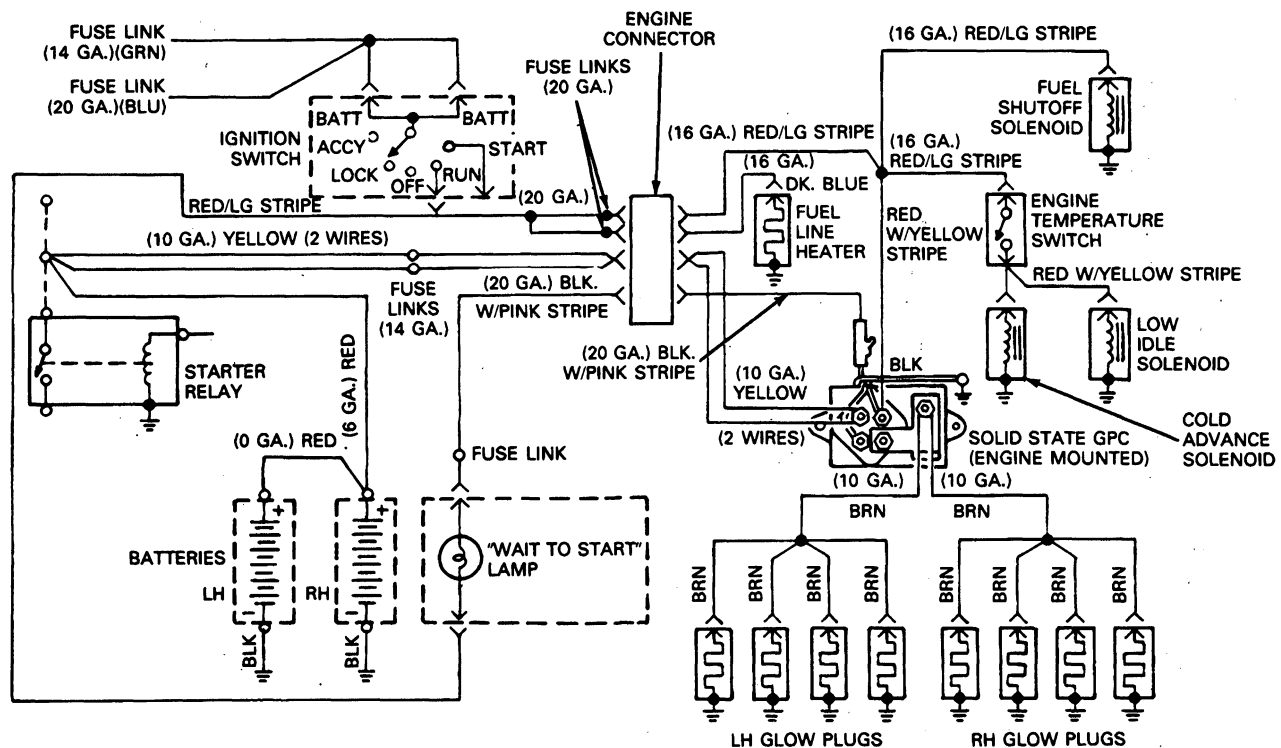
An after-glow operation allows the glow plugs to cycle on and off after the WAIT TO START lamp has turned off. This helps to reduce white smoke during engine warm-up. The lamp will **NOT** cycle on and off during this operation.

DESCRIPTION AND OPERATION (Continued)

The solid-state system determines the glow plug temperature by electronically measuring the resistance of the glow plugs and maintains temperature regardless of ambient conditions. The system uses positive temperature coefficient (PTC) glow plugs with push-on bullet terminals. These are **NOT** interchangeable with previous model year glow plugs.

CAUTION: Never bypass the power relay of the glow plug system. Constant battery current (12 volts) to glow plugs will cause them to overheat and fail, possibly resulting in severe engine damage.

Glow Plug Schematic



A10202-2B

Dual Mass Flywheel (Manual Transmission Only)

The flywheel assembly used on the 7.3L V-8 IDI turbo diesel engine is known as a dual mass flywheel. The purpose of the dual mass flywheel is to provide one inertia mass connected directly to the engine crankshaft and a second inertia mass connected through the clutch system to the transmission. The dual mass flywheel provides the same functions as the conventional flywheel with mounting surfaces for the starter ring gear, clutch pilot bearing and clutch pressure plate and the friction surface for contact with the clutch disc.

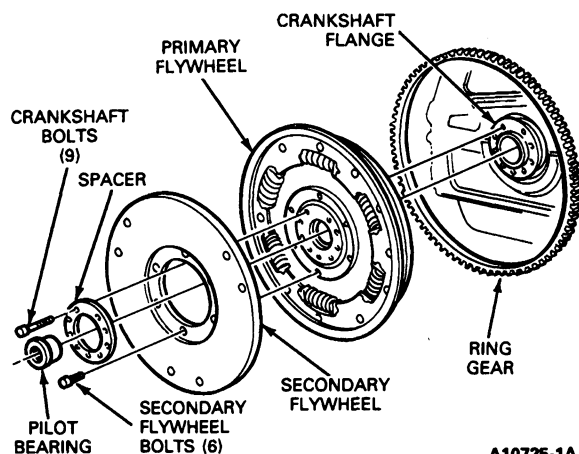
The first inertia mass provides sustaining energy to maintain engine operation between the times that the cylinders fire, and to maintain smooth power delivery.

The second inertia mass provides sustaining energy to the transmission.

Between these two inertia masses a series of springs and friction elements provide smooth, quiet operation and a torque limitation function to protect the drivetrain from impact shock.

DESCRIPTION AND OPERATION (Continued)

The bearing used to mount the second inertia mass onto the first requires no lubrication.



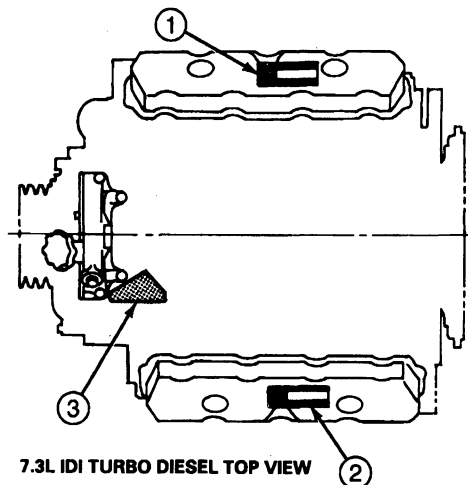
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Vehicle and Engine Identification

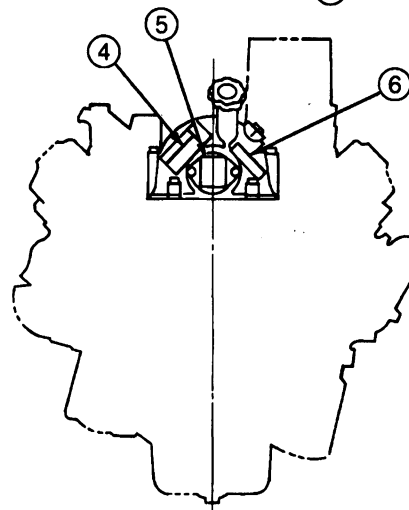
Vehicle identification, the location of the vehicle rating and data plates and engine code information is fully covered in Section 00-01, Identification Codes in this supplement and in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Body/Chassis Manual. For specific and exact engine identification an engine code label is affixed to the gear tower. Refer to the illustrations for examples of engine identification labeling.

Always refer to the engine code label when replacement parts are required or when checking engine calibrations. Some engine parts vary with engine application and vehicle type. The codes contain all pertinent information relating to dates, optional equipment and revisions. The Ford Master Parts Catalog contains a complete listing of the codes and their application. Additional identification information can be found in the permanent engine serial number (stamped on the front side of the crankcase) the emission label (affixed to the valve cover), or the engine serial sequence number label or oil change information label (near the engine code label on front of engine).

Engine Identification



7.3L IDI TURBO DIESEL TOP VIEW



7.3L IDI TURBO DIESEL FRONT VIEW

A20408-A

DESCRIPTION AND OPERATION (Continued)

Engine Code Label

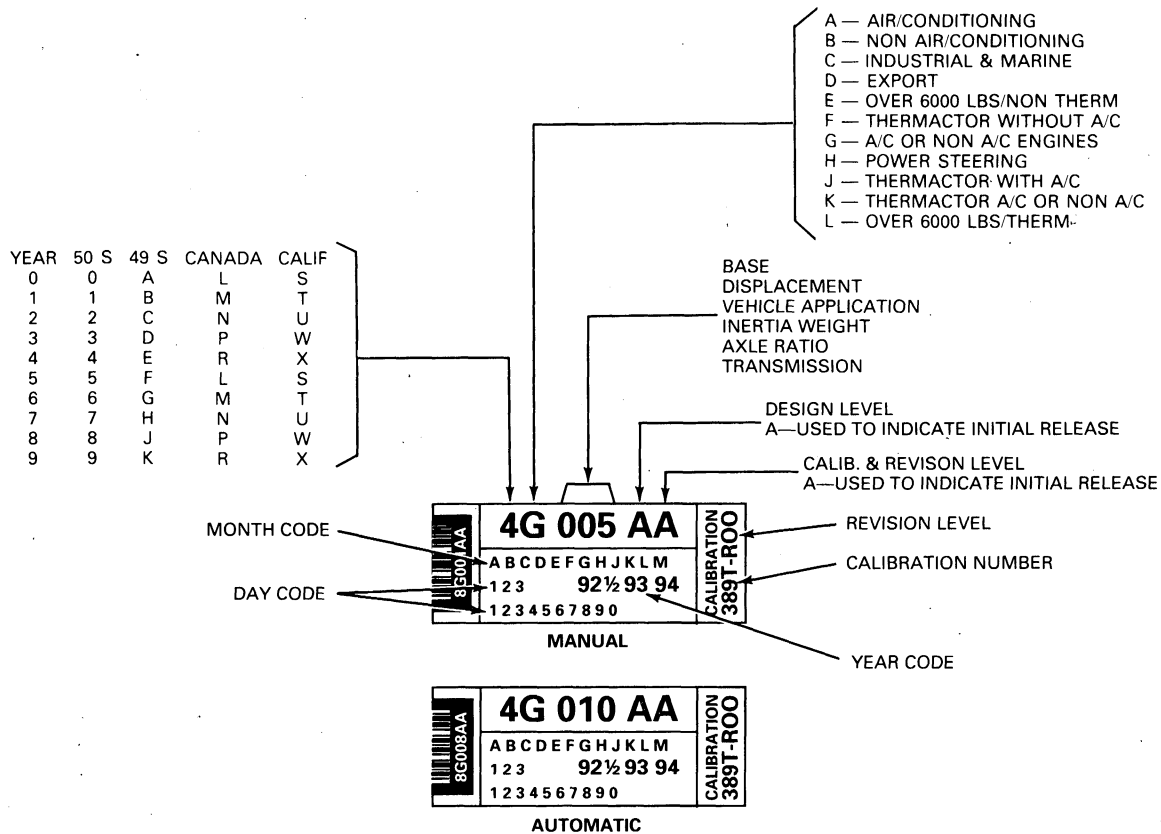
ENGINE SERIAL NUMBER CHART

ENGINE DISPLACEMENT	VARIATION CODE	COUNTRY OF ORIGIN	SERIAL SEQUENCE NUMBER
7.3	TU2	U	XXXXXXX

7.3 = Engine Displacement in Litres
T = Turbocharged
U2 = OEM Application


U = Country of Origin - U.S.A.
 XXXXXXXX = Starting Sequence Number
 * = Used to Prevent Tampering

ENGINE CODE LABEL IDENTIFICATION CHART



A20409-A

Engine Emission Label



INTERNATIONAL

73 ENGINE FAMILY

FAMILLE DE MOTEUR 73

MODEL/MODELE	A166()	A185()
ADV. BHP @ RPM (PUISS. NOM. A TR/MIN)	166 @ 3000	185 @ 3000
FUEL RATE @ ADV. BHP. MM/STROKE. (DEBIT DE CARB. A PUISS. NOM. MM/COURSE)	52.2	58.2

THIS ENGINE HAS A PRIMARY INTENDED SERVICE APPLICATION AS LIGHT HEAVY DUTY DIESEL ENGINE AND CONFORMS TO U.S. EPA CANADIAN AUSTRALIAN AD3030 AND CALIFORNIA REGULATIONS FOR 1993 MODEL YEAR.

CE MOTEUR A ETE PRINCIPALEMENT CONCU ENCE QU'UN MOTEUR DIESEL RUSTE DE GAMME LEGERE. IL EST CONFORME AUX REGLEMENTS CANADIENS APPLICABLES A L'ANNEE DE MODELE 1993.

EMISSION CONTROL INFORMATION

RENSEIGNEMENTS DE DEPOLLUTION

ENGINE MANUFACTURED BY: MOTEUR FABRIQUE PAR: NAVISTAR INTERNATIONAL TRANSPORTATION CORP.

INJECTION TIMING: MARKS ALIGNED. REFER TO ENGINE EMISSIONS DIAGNOSTIC MANUAL FOR DYNAMIC TIMING SPECS.


CALAGE D'INJECTION: REPÈRES ALIGNÉS SE REPORTER AU MANUEL DE DIAGNOSTIC DE DEPOLLUTION DU MOTEUR POUR LES SPECIFICATIONS DU CALAGE DYNAMIQUE.

EM CONTROL SYSTEM-SYST. DE DEPOLLUTION: EM

DISPLACEMENT: CYLINDRE:	CURB IDLE RPM: RÉGIME DE RALENTI. TR/MIN:
7.3L	675

SETTINGS MUST BE MADE WITH ENGINE AT NORMAL OPERATING TEMPERATURE. AIR CONDITIONING OFF. MANUAL TRANSMISSION IN NEUTRAL/AUTOMATIC TRANSMISSION IN DRIVE.

LES REGLAGES DOIVENT ÊTRE EFFECTUÉS ALORS QUE LE MOTEUR A ATTEINT LA TEMPÉRATURE NORMALE DE FONCTIONNEMENT. LE CLIMATISATEUR EST ARRÊTÉ. LA BOÎTE DE VITESSES MANUELLE EST AU POINT MORT/LA BOÎTE AUTOMATIQUE EST EN PRISE.



NAVISTAR®

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A10689-B

DIAGNOSIS AND TESTING

Engine Oil Leaks

TOOLS REQUIRED

Description	Tool Number
Intake Manifold Cover	T83T-9424-A

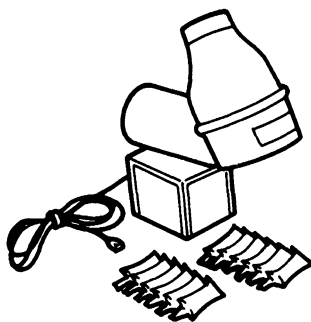
CAUTION: Do not wash or steam clean the engine with engine running. Serious damage to the injection pump could result.

When diagnosing engine oil leaks, the source and location of the leak must be positively identified before any repairs are made. Prior to using this procedure, it is important to clean the cylinder block, cylinder head(s), valve cover(s), oil pan and flywheel housing areas with a suitable solvent to remove all traces of oil.

CAUTION: Do not use an air pressure leak test kit for diagnosing engine oil leaks. Loss of sealing may result at the valley pan seal.

To perform oil leak diagnosis use Oil Leak Detector Rotunda Model 112-00001 or equivalent.

Leak Test Kit Rotunda Model 112-00001



A7911-1A

CAUTION: Dye may cause irritation. Avoid contact with skin or eyes. Wash thoroughly after handling.

1. Open two containers of dye by cutting off end of spout and empty entire contents of containers into crankcase.
2. Drive vehicle for five to ten miles at various road speeds.
3. Turn on spot lamp.
 - Lamp requires 3-5 minutes to warm up.
4. Remove air cleaner assembly.
5. Inspect sealed and/or gasketed areas for leaks with the spot lamp. A leak will appear as a bright contrasting yellow-green fluorescence. Examine the following areas, as required:

Under Hood

- a. Valve cover gaskets and around bolts.
- b. Crankcase front cover gaskets.
- c. Front and rear valley pan end seals.

- d. Cylinder head gaskets.
- e. Injection pump mounting adapter to crankcase.
- f. Injection pump to adapter.
- g. Front oil fill tube and oil fill cap.
- h. Fuel supply pump and/or mounting gasket.
- i. Oil pressure sending unit.
- j. Cup plugs and/or pipe plugs at the end of oil passages.
- k. Turbocharger oil supply tube.
- l. Turbocharger oil drain tube.

Under Engine, With Vehicle on Hoist

- a. The complete oil pan perimeter.
- b. Crankcase front cover gaskets.
- c. Front crankshaft seal.
- d. Oil filter seal.
- e. Oil cooler mounting gaskets and header O-rings.
- f. Fuel supply pump and/or mounting gasket.
- g. Oil level indicator (dipstick) tube connections.

With Transmission Removed

- a. Flywheel mounting bolts.

With Transmission and Flywheel Removed and Flywheel Mounting Bolt Holes Plugged

- a. Rear crankshaft seal.
- b. Rear cup plugs and/or pipe plugs.
- c. Rear cover gasket.
- d. Rear cover oil pan seal.

NOTE: Install specified sealant on flywheel bolts and install flywheel as outlined in this section.

Oil Cooler Internal Leakage Test

When oil is found in the cooling system or coolant in the oil, the oil cooler assembly should be inspected for leakage.

Areas of possible leakage are:

- O-rings
- Oil cooler bundle (tubes)
- Front header
- Rear header

Clean the cooling system if oil is found in the coolant. Refer to Section 03-03 in this Supplement. If coolant is found in the oil, change engine oil and filter.

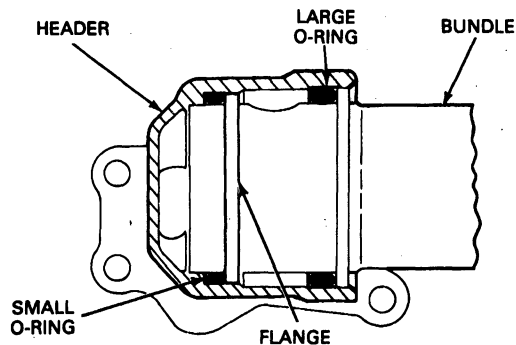
1. Remove oil cooler assembly from engine with filter installed as outlined in this section.

DIAGNOSIS AND TESTING (Continued)

2. Inspect the gaskets at the header flanges for leakage of coolant into the oil or oil into the coolant.
 NOTE: Use original oil cooler tube and NOT test cooler tube included with Rotunda model 014-00726 Oil Cooler Internal Leakage Tester or equivalent.
3. Using new header gaskets, assemble Rotunda Oil Cooler Internal Leakage Tester 014-00726 or equivalent to the engine oil cooler. Follow instructions provided with kit.

Oil Cooler Internal Leakage Test Equipment, Rotunda Model 014-00726

NOTE: Install the large O-ring on the oil cooler bundle first, then install the small O-ring on the cooler bundle.



NOTE:
 INSTALL THE LARGE O-RING ON THE OIL COOLER BUNDLE FIRST, THEN INSTALL THE SMALL O-RING ON THE COOLER BUNDLE.

A8704-C

4. Pressurize coolant side of front header test plate (adapter A) at air supply fitting with 276.8 kPa (40 psi) air pressure.
5. Check for air leakage at the plastic tube or each header cover plate. If air leakage is not felt, place a cup of water up to the plastic tubes and look for bubbles. There should be no bubbles for a one-minute time period.
 - If no leakage is observed, the complete oil cooler assembly (headers, O-rings and cooler bundle tube) **DOES NOT** have an internal leak. Install the oil cooler assembly to the engine as outlined in this section. Continue engine diagnostic procedures to identify the source of the leak.
 - Steps 3 through 5 may also be used as a functional test of a newly overhauled oil cooler assembly.
6. If air leakage is observed, unbolt the test kit tie bar and remove the front and rear headers from the cooler bundle (with cover plates attached to headers). Replace the four cooler bundle O-rings.

7. Bolt the test kit tie bar to the rear header cover plate. Repeat Steps 4 and 5 with the cooler assembly submerged in water. If leakage persists, isolate the worn or damaged component in the oil cooler assembly as follows:
 - a. For a leaking oil cooler still covered by warranty (3 years, 80,465km or 50,000 miles) go to Step 8.
 - b. For a leaking oil cooler not covered by warranty go to Step 10.
8. For a leaking oil cooler covered by warranty, replace and retest the following oil cooler components in the following sequence until no leakage is observed:
 - a. Front header
 - b. Rear header
 - c. Cooler bundle (tube)
 NOTE: Prior to each retest, inspect the condition of the affected header gasket(s) and O-rings and replace if damaged.
9. Assemble the affected test kit cover plate(s) and tie bar. Repeat Steps 4 and 5 with cooler assembly submerged in water. If leak persists, replace the next component listed in Step 8. If no leakage was observed, go to Step 12.
10. For a leaking oil cooler not covered by warranty, replace and test the following oil cooler components in the following sequence until no leakage is observed:
 - a. Cooler bundle (tube)
 - b. Front header
 - c. Rear header
 - Prior to each retest, inspect the condition of the affected header gasket(s) and O-rings, replace if damaged.
11. Assemble the affected test kit cover plate(s) and tie bar. Repeat Steps 4 and 5 with cooler assembly submerged in water. If leak persists, replace the next component listed in Step 8. If no leakage was observed, go to Step 12.
12. Install oil cooler assembly onto engine with new gaskets as outlined.

Compression Test

The following procedure is to be used when checking compression:

1. Make sure battery is fully charged. Operate the engine until normal operating temperature is reached. Turn the ignition switch to OFF. Remove air cleaner and / or intake opening cover. Disconnect injection pump solenoid leads from injection pump to prevent accidental engine starting. Remove all glow plugs.
2. Install Rotunda Compression Tester 014-00701 or equivalent in No. 1 cylinder glow plug hole.

DIAGNOSIS AND TESTING (Continued)

3. Remove the turbocharger assembly. Refer to Section 03-12B in this Supplement.
4. Crank the engine (with the ignition switch off) at least five pumping strokes. Record highest reading indicated. Note the approximate number of compression strokes required to obtain the highest reading.
5. Repeat the check on each cylinder, cranking the engine approximately the same number of compression strokes.

Test Conclusion

Compression pressures are considered normal if the lowest reading cylinder is within 75 percent of the highest. Variations exceeding 75 percent indicate an improperly seated valve or worn or broken piston rings.

CAUTION: Do not add oil to cylinder. This could cause hydrostatic lock.

Compression Test Pressures

HIGHEST CYLINDER	LOWEST CYLINDER
Maximum kPa (PSI)	Minimum kPa (PSI)
1792 (260)	1344 (195)
1929 (280)	1447 (210)
2067 (300)	1551 (225)
2205 (320)	1654 (240)
2343 (340)	1757 (255)
2481 (360)	1860 (270)
2619 (380)	1964 (285)
2756 (400)	2067 (300)
2894 (420)	2171 (315)
3032 (440)	2274 (330)

CA7414-1B

Hydraulic Valve Tappet**TOOLS REQUIRED**

Description	Tool Number
Tappet Bleed-Down Wrench	T83T-6500-A

Hydraulic tappet noise may be caused by any of the following:

1. Excessive collapsed tappet gap.
2. Sticking tappet plunger.
3. Tappet check valve not functioning properly.
4. Air in lubrication system.
5. Leakdown rate too rapid.

6. Excessive valve guide wear.

Excessive collapsed tappet gap may be caused by loose rocker arm fulcrum bolts, or wear of tappet roller, push rod, rocker arm, rocker arm fulcrum or valve tip. Using Tappet Bleed-Down Wrench T83T-6500-A collapse tappet and check gap between valve tip and rocker arm to determine if any valve train parts are damaged, worn, or out of adjustment.

A sticking tappet plunger may be caused by dirt, chips, or varnish inside the tappet. Sticking plungers can sometimes be serviced by disassembling the tappet and removing the dirt, chips or varnish causing the condition.

A non-functional tappet check valve may be caused by an obstruction (dirt or chips) preventing it from closing when the cam lobe is lifting the tappet. Non-functional tappet check valves may also be caused by a broken check valve spring.

Air bubbles in the lubrication system prevent the tappet from supporting the valve spring load. Bubbles may be caused by too high or too low an oil level in the oil pan, by air being drawn into the system through a hole or crack, or a leaking gasket on the oil pump pickup tube.

If leakdown time is below specifications for used tappets, noisy operation may result. If no other cause for noisy tappets can be found, check leakdown rate and replace any outside the specification. Refer to Leakdown Testing in Section 03-00 in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual. The procedures are the same for diesel and gasoline engines.

Static (Engine Off) Valve Train Analysis**Rocker Arm Cover Removal**

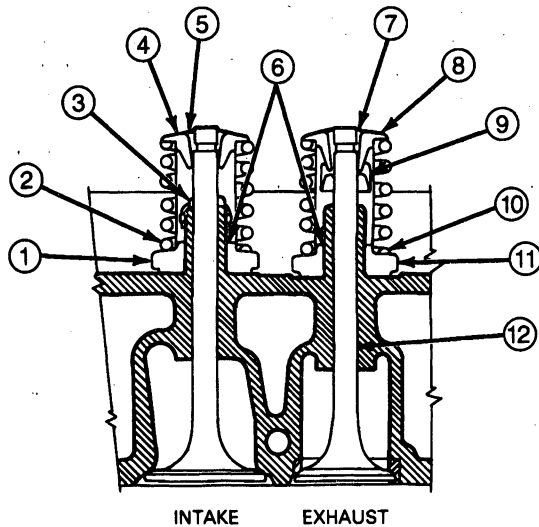
Remove rocker arm covers as outlined in this section.

Valve Train Analysis

Check for damaged and / or severely worn parts; for correct assembly and use of correct parts.

1. Check rocker arm assemblies for loose mounting bolts or plugged rocker arm oil hole.
2. Check for bent push rods or clogged passages.
3. Check valve spring assembly for broken or damaged parts.
4. Check retainer and keys for proper seating of keys on valve stem in retainer.
5. Check for proper seating of the positive valve rotator.
6. Check valves and cylinder head. Check cylinder head gasket for proper installation. Check for plugged oil drain holes, worn or damaged valve tips, missing or damaged valve stem oil seals. Check collapsed tappet gap.

DIAGNOSIS AND TESTING (Continued)



A15993-A

Item	Part Number	Description
1	6K533	Valve Rotator
2	6513	Spring with Damper
3	6571	Valve Stem Seal (Intake Only)
4	6514	Retainer
5	6518	Retainer Lock
6	6510	Valve Guide
7	6514	Retainer Lock
8	6518	Retainer
9	6517	Oil Shield (Exhaust Only)
10	6513	Spring with Damper
11	6K533	Valve Rotator
12	—	Valve Guide Bore

Camshaft Lobe Lift

TOOLS REQUIRED

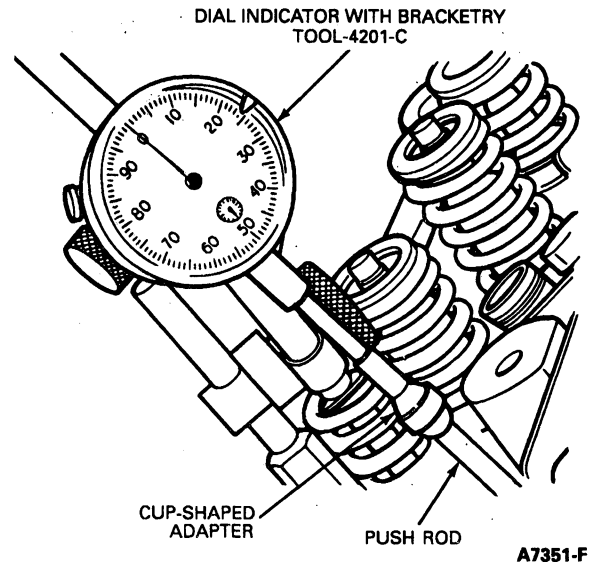
Description	Tool Number
Intake Manifold Cover	T83T-9424-A
Dial Indicator with Bracketry	TOOL-4201-C

Check lift of each lobe (in consecutive order) and make a note of readings.

1. Remove air intake duct and air cleaner assembly.
2. Remove turbocharger assembly. Refer to Section 03-12B in this Supplement.
3. Install Intake Manifold Cover T83T-9424-A.
4. Remove glow plug controller from right valve cover.
5. Remove valve cover(s) as outlined.
6. Remove fulcrum bolts, fulcrum seats and rocker arms as outlined.

7. Make sure push rod is in valve tappet socket. Install Dial Indicator D78P-4201-G and Dial Indicator Bracketry with Bracketry TOOL-4201-C or D78P-4201-F or equivalent so that indicator ball socket adapter using suitable cup-shaped adapter is on the end of the push rod and in the same plane as push rod movement.

Camshaft Lobe Lift Test



NOTE: Remove glow plugs with Glow Plug Socket D83T-6002-A or equivalent to facilitate turning engine over by hand.

8. Rotate crankshaft by hand until tappet is on base circle of crankshaft lobe. At this point, push rod will be in its lowest position.
9. Zero dial indicator. Continue to rotate crankshaft slowly until push rod is in fully raised position.
10. Compare total lift recorded on indicator with specification.
11. To check accuracy of original indicator reading, continue to rotate crankshaft until the indicator reads zero. If the lift on any lobe is below specified wear limits, the camshaft and the valve tappet operating on the worn lobe(s) must be replaced.
12. Remove the dial indicator.
13. Install rocker arms, fulcrum seats and fulcrum bolts as outlined. Tighten bolts to specification.
14. Install the valve cover(s) as described in this section. Tighten bolts to specification.
15. Remove intake manifold cover, install air cleaner and tighten to specification.

Valve Cover Installation

Install both valve covers as outlined in this section.

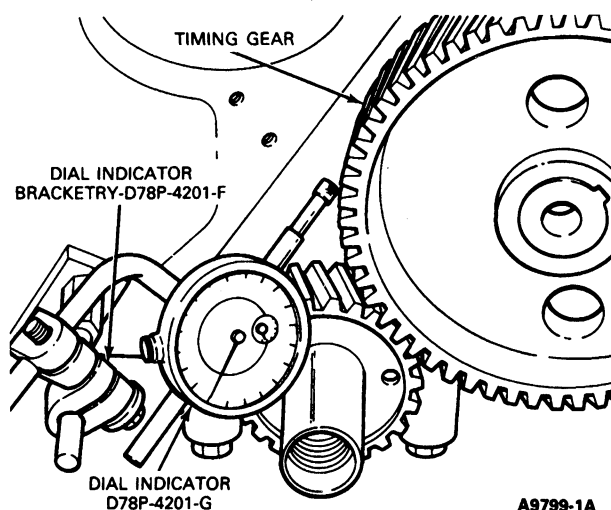
DIAGNOSIS AND TESTING (Continued)**Camshaft End Play**

Refer to diagnosis and testing procedure in Section 03-00, Engine Service, Gasoline in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual. This procedure is the same for diesel and gasoline engines.

Drive Gear Backlash (All Gears)

Remove engine front cover as outlined in this section.

Install Dial Indicator Bracketry D78P-4201-F and Dial Indicator D78P-4201-G or equivalent on the cylinder block. Check the backlash between the drive gear and the driven gear with a dial indicator at six equally spaced teeth. Hold the gear firmly against the block while making the check. Refer to Specifications for backlash limits.

**Crankshaft End Play**

Refer to Section 03-00 Engine Service, Gasoline in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual. This procedure is the same for diesel and gasoline engines.

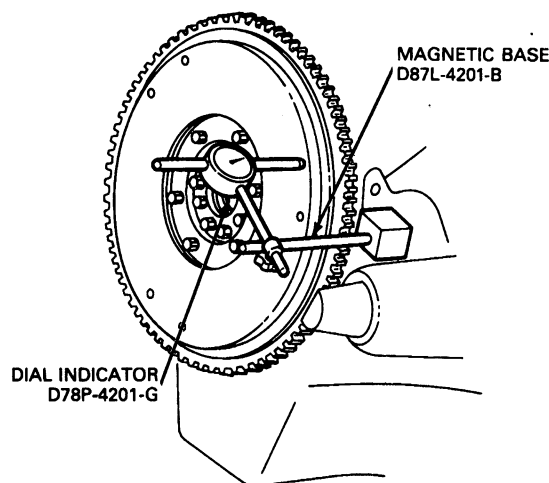
Flywheel Runout, Manual Transmission

NOTE: This procedure is performed with transmission removed. Refer to Group 07 in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.

NOTE: Remove glow plugs with Glow Plug Socket D83T-6002-A or equivalent to facilitate turning engine over by hand.

Install Dial Indicator Bracketry D78P-4201-F and Dial Indicator D78P-4201-G or equivalent so that the indicator point bears against the flywheel face, one-inch from the edge of the flywheel. Zero the dial indicator. Turn flywheel, making sure it is fully forward or rearward so that crankshaft end play will not be indicated as flywheel runout.

If flywheel clutch face runout exceeds specifications listed at the end of this section, remove flywheel. Check for burrs between flywheel and face of the crankshaft mounting flange. If no burrs exist, check crankshaft mounting flange runout. If excessive, machine mounting flange or replace crankshaft. If not excessive, reface or replace secondary flywheel. If the ring gear runout exceeds specifications, check installation of gear to flywheel flange. If it is not properly seated, re-install it to flywheel. If it is properly seated, replace it. Refer to Flywheel Ring Gear, Removal and Installation in this section for applicable procedures.

**Flywheel Runout, Automatic Transmission**

Remove the glow plugs with Glow Plug Socket D83T-6002-A or equivalent to facilitate turning engine over by hand.

Install a dial indicator so that the indicator point rests on the ring gear face adjacent to the gear teeth.

Push the flywheel and crankshaft fully forward or rearward to prevent crankshaft end play from being indicated as flywheel runout.

DIAGNOSIS AND TESTING (Continued)

Zero the dial indicator. Turn the flywheel one complete revolution while observing the total indicator reading (TIR). If TIR exceeds specifications listed at the end of this section, remove flywheel and check for burrs between flywheel and face of crankshaft mounting flange. If no burrs exist, check runout of crankshaft mounting flange. If crankshaft flange face exceeds specifications, machine the mounting flange or replace crankshaft. If crankshaft flange face runout is not excessive, check installation of ring gear to flywheel. If not properly seated, remove and reinstall ring gear to flywheel. If ring gear is properly seated, replace flywheel.

Diagnostic Procedures, Engine Performance and Glow Plug System

Diagnostic procedures for engine performance, fuel injection and glow plug fast start system are covered in Section 20A Diesel Diagnosis, 7.3L IDI Turbo Engine in this Supplement. Injection pump timing and nozzle performance are also covered in Section 20A Diesel Diagnosis, 7.3L IDI Turbo Engine in this Supplement.

REMOVAL AND INSTALLATION

NOTE: Lightly oil attaching bolt and stud threads before installing, except those specifying special sealant.

Engine Assembly**TOOLS REQUIRED**

Description	Tool Number
Intake Manifold Cover	T83T-9424-A
Fan Clutch Pulley Holder	T83T-6312-A
Fan Clutch Nut Wrench	T83T-6312-B

Removal

1. Disconnect both battery ground cables.
2. Scribe alignment marks at hood hinges for reference during installation. Remove hood.
3. Drain cooling system. Refer to Section 03-03, Engine Cooling, in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
4. Remove air cleaner and intake duct assembly.
5. Remove radiator fan shroud.
CAUTION: Left-hand thread. Remove by turning nut clockwise.
6. Remove fan and clutch assembly as outlined, using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.

7. Disconnect radiator upper and lower hoses from radiator.
8. Disconnect automatic transmission oil cooler lines at radiator, if so equipped.
9. Remove radiator. Refer to Section 03-03, Engine Cooling, in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
10. Remove accessory drive belt.
11. Remove air conditioner compressor, and position it on radiator upper support, refer to Section 12-03A Air Conditioning, Heater System, F-Series and Bronco, Manual in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Body / Chassis Manual.
12. Remove power steering pump and position out of the way on left side of engine compartment.
13. Disconnect alternator wires at alternator.
14. Disconnect oil pressure sending unit wire at sending unit located at turbocharger assembly.
15. Disconnect accelerator cable from injection pump.
16. Disconnect speed control cable from injection pump, if so equipped.
17. Remove accelerator cable bracket (with cables attached), from intake manifold and position out of the way.
18. Disconnect transmission kick down rod from injection pump, if so equipped.
19. Disconnect main wiring harness connector from left side of engine.
20. Disconnect engine ground strap from rear of engine.
21. Disconnect fuel return hose from left rear of engine.
22. Remove vacuum supply hose from vacuum pump.
23. Remove two upper transmission-to-engine attaching bolts.
24. Disconnect heater hoses from water pump and right cylinder head.
25. Disconnect water temperature sender wire from sender on left front of engine block.
26. Disconnect water temperature overheat lamp switch wire from switch on top front of left cylinder head.
27. Position wires out of the way.
28. Raise vehicle.
29. Disconnect both battery ground cables from lower front of engine.
30. Disconnect and cap fuel inlet line at fuel supply pump.
31. Disconnect starter cables at starter motor.
32. Disconnect engine exhaust charge pipe from turbocharger.

REMOVAL AND INSTALLATION (Continued)

33. Remove exhaust crossover pipe and Y-collector pipe.
 34. Disconnect engine insulators from No. 1 crossmember.
 35. Remove flywheel inspection plate.
 36. Remove four converter-to-flywheel attaching nuts, if so equipped.
 37. Lower vehicle.
 38. Remove turbocharger assembly. Refer to Section 03-12B in this Supplement.
 39. Support transmission. Remove four lower transmission-to-engine attaching bolts.
 40. Attach Rotunda Universal Load Positioning Sling 014-00036 or equivalent to engine.
- CAUTION: Use care not to damage windshield wiper motor when lifting engine out of vehicle.**
41. Raise engine high enough to clear No. 1 crossmember and pull forward.
 42. Rotate the front of the engine approximately 45 degrees to the left and lift it out of the engine compartment.

Installation

NOTE: If the engine to be installed has been overhauled or has been in storage, take the following precaution to prevent piston and bearing scuffing. Prime the entire engine lubricating system to fill the oil cooler, oil filter and cylinder block galleries with the specified type and grade of oil.

CAUTION: Use care not to damage windshield wiper motor when installing engine into vehicle.

1. Lower engine into engine compartment.
2. Start transmission mainshaft into clutch disc. It may be necessary to adjust position of transmission in relation to engine if mainshaft binds or will not enter clutch disc. If engine hangs up after mainshaft enters clutch disc, rotate crankshaft slowly (transmission in gear) until mainshaft splines mesh with clutch disc splines.
3. Align torque converter with flywheel studs, if so equipped.
4. Lower engine onto engine insulator brackets on No. 1 crossmember.
5. Install four lower transmission-to-engine attaching screws and lockwashers and tighten to 54-68 N-m (40-50 ft-lb).
6. Remove engine lifting sling.
7. Install turbocharger assembly. Refer to Section 03-12B in this Supplement.
8. Raise vehicle.
9. Install four torque converter-to-flywheel attaching nuts, if so equipped, and tighten to specifications.
10. Install flywheel inspection plate and tighten bolts to specifications.

11. Install engine insulator support-to-crossmember bracket attaching nuts and washers and tighten to 102-129 N-m (75-95 ft-lb).
12. Connect both battery ground cables to the lower front of the engine and tighten bolts to specifications.
13. Connect starter cables to starter and tighten to specifications.
14. Install fuel pump inlet line onto fuel pump and tighten to specifications.
15. Lower vehicle.
16. Connect water temperature sender wire to sender on left front of engine block.
17. Connect wire to water temperature overheat lamp switch on top of left cylinder head.
18. Install heater hoses onto right cylinder head and water pump and tighten clamps to 2-3 N-m (18-27 in-lb) double-wire clamp, 3-4 N-m (27-35 in-lb) screw-type clamp.
19. Connect engine ground strap at rear of engine.
20. Connect main wiring harness connector to left side of engine.
21. Connect fuel return hose at left rear of engine.
22. Connect vacuum supply hose to vacuum pump.
23. Connect transmission kickdown rod, if so equipped.
24. Install accelerator cable bracket onto intake manifold and tighten to 16-23 N-m (15-18 ft-lb).
25. Connect accelerator cable to injection pump.
26. Connect speed control cable, if so equipped, to injection pump.
27. Connect oil pressure gauge sender wire to oil pressure sender.
28. Connect alternator wires to alternator.
29. Install power steering pump.
30. Install air conditioning compressor and accessory drive belt. Refer to Section 12-03A, Air Conditioning, Heater System, F-Series and Bronco, Manual in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Body / Chassis Manual.
31. Install radiator. Refer to Section 03-03, Engine Cooling in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
32. Connect automatic transmission oil cooler lines at radiator, if so equipped. Refer to Section 07-01A, Transmission, Automatic, E4OD in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
33. Connect upper and lower radiator hoses to radiator and tighten hose clamps to 3-4 N-m (26-35 in-lb) screw clamps, 2-3 N-m (18-27 in-lb) double-wire clamps.

REMOVAL AND INSTALLATION (Continued)

34. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
CAUTION: Left-hand thread. Turn nut counterclockwise to tighten.
35. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.
Tighten nut to 54-163 N·m (40-120 ft-lb).
36. Install radiator fan shroud. Tighten bolts to 4-8 N·m (35-71 in-lb).
37. Install intake duct assembly.
38. Install hood, aligning scribe marks drawn on hood during removal.
39. Connect battery ground cables at both batteries.
40. Check the engine oil level and fill as needed with specified type and grade of oil.
41. Run engine and check for fuel, oil and coolant leaks.

Engine Front Insulators**TOOLS REQUIRED**

Description	Tool Number
Intake Manifold Cover	T83T-9424-A

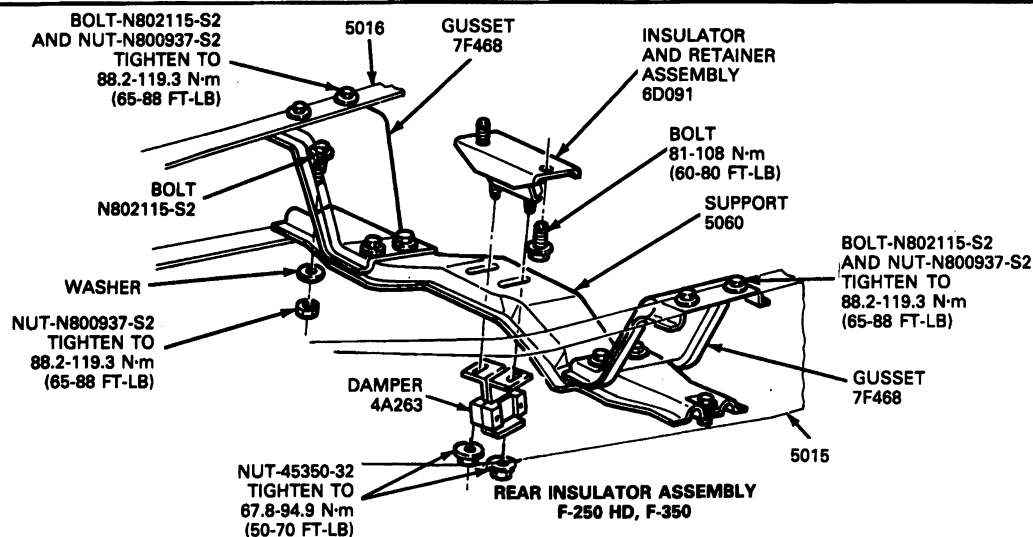
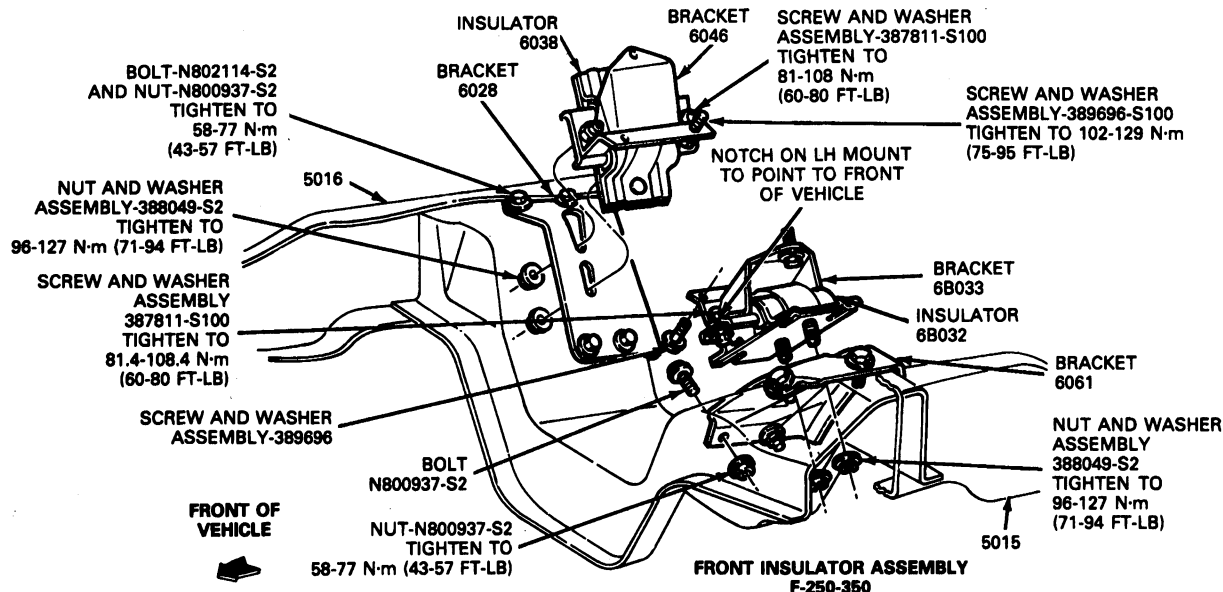
Removal and Installation

1. Disconnect ground cables from both batteries.
2. Remove fan shroud attaching bolts and remove fan shroud.
3. Remove air cleaner assembly and air duct.
4. Remove turbocharger assembly, refer to Section 03-12B in this Supplement.
5. Install Intake Manifold Cover T83T-9424-A.
6. Raise vehicle.
7. Remove nuts attaching insulators to crossmember.
8. Remove engine charge exhaust pipe from muffler exhaust pipe.
9. Remove bolts attaching insulators to engine block.
10. Lower vehicle.
11. Install Rotunda Universal Load Positioning Sling 014-00036 or equivalent to lifting eyes on engine and raise engine high enough for insulators to clear crossmember.
12. Remove insulator and bracket assemblies.
13. Remove insulator from bracket.

For installation, follow removal steps in reverse order. Tighten fan shroud bolts to 4-8 N·m (35-71 in-lb). Refer to illustration for insulator torque specifications.

REMOVAL AND INSTALLATION (Continued)

Engine Insulators, F-250-350



A7898-D

Water Pump

TOOLS REQUIRED

Description	Tool Number
Fan Clutch Pulley Holder	T83T-6312-A
Fan Clutch Nut Wrench	T83T-6312-B

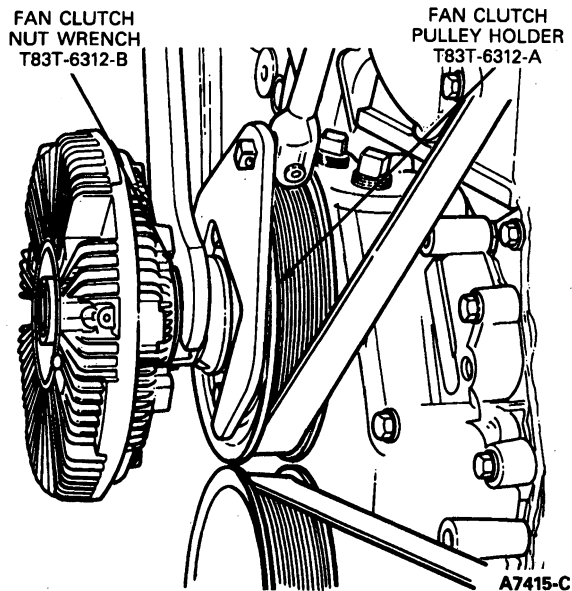
Removal

1. Disconnect battery ground cables from both batteries.
2. Drain cooling system.

3. Remove radiator fan shroud.
CAUTION: Left-hand thread: Remove by turning nut clockwise.
4. Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.
5. Remove accessory drive belt.
6. Remove water pump pulley.
7. Disconnect heater hose from water pump.
8. Remove heater hose fitting from water pump.

REMOVAL AND INSTALLATION (Continued)

9. Remove bolts attaching water pump to front cover and remove pump.

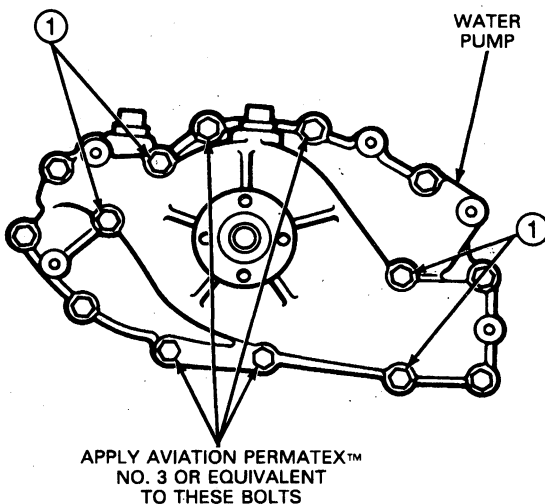


Installation

NOTE: Coat two top bolts and two bottom bolts with Aviation Permatex™ No. 3 or equivalent before installation. Install bolts within five minutes of sealer application. Make sure that correct length bolts are installed in correct holes.

1. Clean water pump and engine front cover mating surfaces with suitable solvent. Clean bolt threads.

Water Pump



APPLY AVIATION PERMATEX™
NO. 3 OR EQUIVALENT
TO THESE BOLTS

- ① THESE BOLTS ARE 2 3/4-INCHES LONG.
ALL OTHERS ARE 1 1/2 INCHES LONG.

2. Install water pump with new gasket and tighten to 19 N·m (14 ft-lb).

3. Install water pump pulley and tighten to standard torque specifications, see chart at end of this section.
4. Coat heater hose fitting with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent and install in water pump. Tighten to 17-24 N·m (13-18 ft-lb).
5. Connect heater hose to water pump and tighten clamp to specifications.
6. Install accessory drive belt.
- CAUTION: Left-hand thread. Turn nut counterclockwise to tighten.**
7. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B and tighten to 54-163 N·m (40-120 ft-lb).
8. Install radiator fan shroud. Tighten bolts to 4-8 N·m (35-71 in-lb).
9. Fill and bleed cooling system. Refer to Section 03-03, Engine Cooling in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
10. Connect ground cables to both batteries.
11. Run engine and check for coolant leaks.

Crankshaft Vibration Damper

TOOLS REQUIRED

Description	Tool Number
Fan Clutch Pulley Holder	T83T-6312-A
Fan Clutch Nut Wrench	T83T-6312-B
Flywheel Holding Tool	T74P-6375-A
Crank/Cam Gear and Damper Remover	T83T-6316-A
Crank/Cam Gear and Damper Replacer	T83T-6316-B

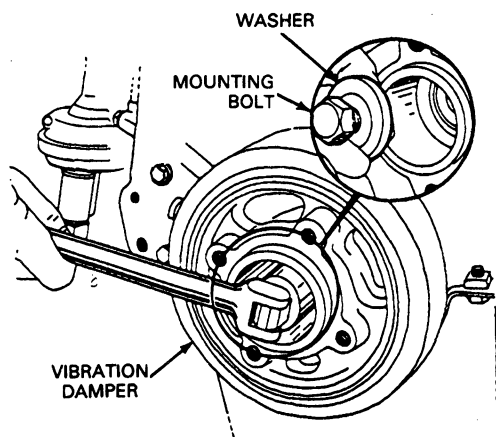
Removal

1. Disconnect ground cables from both batteries.
2. Remove radiator fan shroud.
- CAUTION: Left-hand thread. Remove by turning nut clockwise.**
3. Remove fan and clutch assembly as outlined using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent.
4. Remove accessory drive belt.
5. Raise vehicle.
6. Remove crankshaft pulley.
7. Remove bolt attaching damper to crankshaft.

NOTE: To prevent crankshaft rotation, use breaker bar for in vehicle removal or Flywheel Holding Tool T74P-6375-A for bench overhaul.

REMOVAL AND INSTALLATION (Continued)

8. Install Crank / Cam Gear and Damper Remover T83T-6316-A and remove crankshaft damper.



A10727-1A

Installation

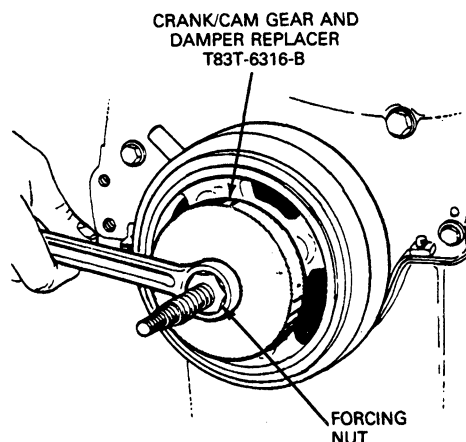
NOTE: A new front crankshaft seal should be installed whenever the crankshaft damper is removed.

NOTE: Add Silicone Rubber Sealant D6AZ-19562-AA or -BA (ESB-M4G92-A) or equivalent to engine side of washer (in area of keyway only) to prevent oil leakage past keyway.

1. Lubricate the damper seal nose with clean engine oil, and install using Crank / Cam Gear and Damper Replacer T83T-6316-B.
2. Install bolt attaching damper to crankshaft and tighten to 122 N·m (90 ft-lb).
3. Install crankshaft pulley and tighten to standard torque specifications, see chart at end of section.
4. Lower vehicle.
5. Install accessory drive belt.

CAUTION: Left-hand thread. Turn nut counterclockwise to tighten.

6. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B. Tighten nut to 54-163 N·m (40-120 ft-lb).
7. Install radiator fan shroud. Tighten bolts to 4-8 N·m (35-71 in-lb).
8. Connect ground cables to both batteries.



A10728-1A

Front Crankshaft Oil Seal, In-Vehicle Replacement

NOTE: This procedure is for replacing front crankshaft oil seal without removing the front engine cover.

TOOLS REQUIRED

Description	Tool Number
Crank / Cam Gear and Damper Remover	T83T-6316-A
Front Crank Seal Replacer	T83T-6700-A
Crank / Cam Gear and Damper Replacer	T83T-6316-B
Fan Clutch Pulley Holder	T83T-6312-A
Fan Clutch Nut Wrench	T83T-6312-B

Removal

1. Disconnect battery ground cables from both batteries.
2. Remove radiator fan shroud.
CAUTION: Left-hand thread. Remove by turning nut clockwise.
3. Remove fan and clutch assembly as outlined.
4. Remove accessory drive belt.
5. Raise vehicle.
6. Remove crankshaft pulley.
7. Remove bolt attaching damper to crankshaft.
8. Install Crank / Cam Gear and Damper Remover T83T-6316-A and remove crankshaft vibration damper. To prevent crankshaft rotation install breaker bar into removal tool.
CAUTION: Use care to prevent damage to the front cover or crankshaft. Bending front cover will break oil pan seal.
9. Pry out front oil seal from the front cover using a screwdriver.

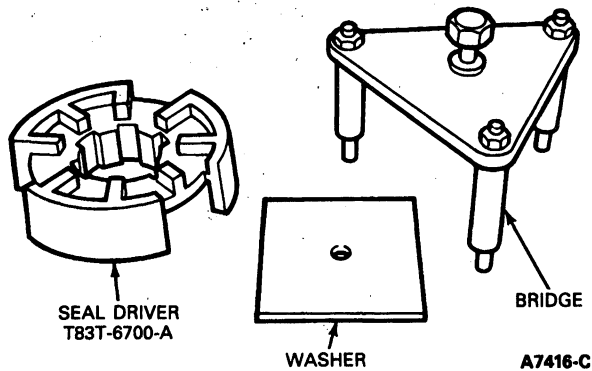
Installation

NOTE: It may be necessary to rotate crankshaft to align the damper key with seal installing tool.

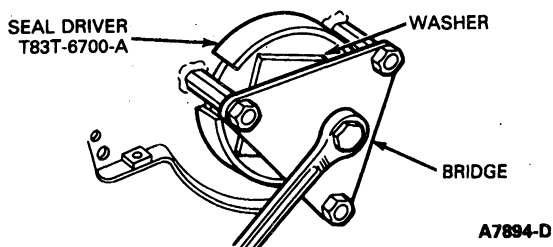
REMOVAL AND INSTALLATION (Continued)

CAUTION: Use care to prevent bending front cover and breaking oil pan seal during oil seal installation.

1. Coat new oil seal with Multi-Purpose grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent.



2. For engines without three weldnuts on front cover, place seal into Front Crank Seal Replacer T83T-6700-A and install over end of crankshaft. Install Crank / Cam Gear and Damper Replacer T83T-6316-B and tighten nut against washer and installation tool to force seal into front cover plate.
3. For engines with three weldnuts on front cover, place seal into seal driver, install over end of crankshaft, place washer on seal driver and attach bridge to weldnuts. Draw seal into front cover by rotating center screw clockwise.
 - Seal is automatically installed at the proper depth when the tool bottoms on the front cover.



4. Clean grease from outside surfaces and apply a 3.2mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent around the outside diameter of the front seal and the edge of the front cover.
 - When applying RTV rubber silicone sealant, always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to set-up and its sealing effectiveness may be reduced.
5. Lubricate the damper seal nose with clean engine oil and install crankshaft vibration damper using Crank / Cam Gear and Damper Replacer T83T-6316-B.

6. Add Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent to engine side of washer (in area of keyway only), to prevent oil leakage past keyway. Install bolt attaching vibration damper to crankshaft and tighten to specification.
7. Install crankshaft pulley and tighten to specification.
8. Lower vehicle.
9. Install accessory drive belt.

CAUTION: Left-hand thread. Turn nut counterclockwise to tighten.
10. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B. Tighten nut to 54-163 N·m (40-120 ft-lb).
11. Install radiator fan shroud. Tighten bolts to 4-8 N·m (35-71 in-lb).
12. Connect ground cables to both batteries.

Engine Front Cover and Crankshaft Oil Seal

NOTE: Whenever the engine front cover is removed, the crankshaft front seal must also be replaced.

TOOLS REQUIRED

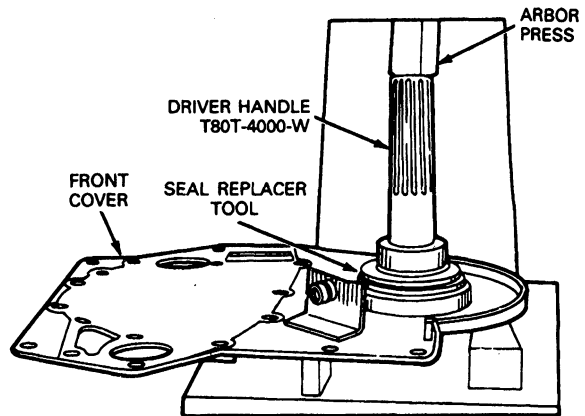
Description	Tool Number
Intake Manifold Cover	T83T-9424-A
Drive Handle	T80T-4000-W
Front Crank Seal Replacer	T83T-6700-A
Crank / Cam Gear and Damper Replacer	T83T-6316-B
Fan Clutch Pulley Holder	T83T-6312-A
Fan Clutch Nut Wrench	T83T-6312-B

Removal

1. Disconnect ground cables from both batteries.
2. Drain cooling system.
3. Remove upper and lower air cleaner housing and cap turbocharger compressor opening.
4. Remove water pump as outlined in this section.
5. Remove injection pump as outlined in this section.
6. Remove injection pump adapter as outlined in this section.
7. Raise vehicle.
8. Remove crankshaft pulley and vibration damper, as outlined in this section.
9. Remove ground cables at front of engine.
10. Remove five bolts attaching front cover to engine block and oil pan.
11. Lower vehicle.
12. Remove bolts attaching engine front cover to engine block, and remove front cover.

REMOVAL AND INSTALLATION (Continued)

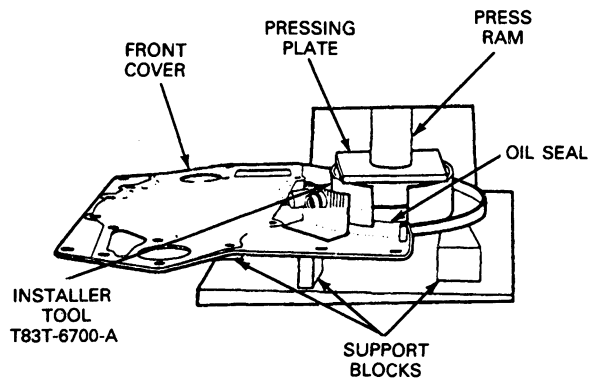
13. Support engine front cover, and using an arbor press, Drive Handle T80T-4000-W and an 82.55mm (3-1/4-inch) diameter spacer, drive crankshaft seal out of front cover.



A7357-1B

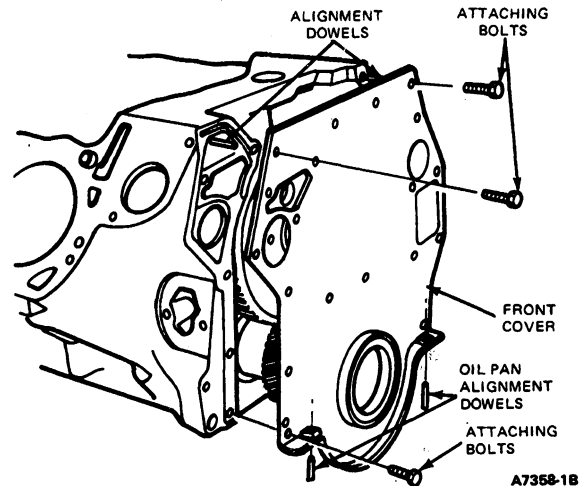
Installation

1. Remove old gasket material and clean engine block, engine front cover, and oil pan sealing surfaces with a suitable solvent and dry thoroughly.
 2. Clean water pump sealing surface.
 3. Coat new front crankshaft oil seal with Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent.
- CAUTION: Support engine front cover.**
4. Install new oil seal using Front Crank Seal Replacer T83T-6700-A, a suitable spacer, and an arbor press. Bottom out tool on front cover surface. Seal is automatically installed at proper depth.



A10729-1A

5. Clean outside surfaces of the front cover to remove any grease and apply a 3.2mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent around the outside diameter of the front seal and the edge of the front cover.
6. For in-vehicle repair, install fabricated alignment dowels on engine block and oil pan to align front cover and gaskets. For overhaul repair, install fabricated alignment dowels as shown.



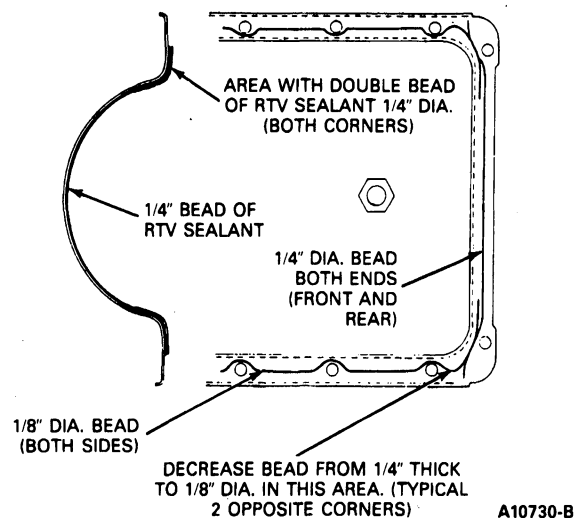
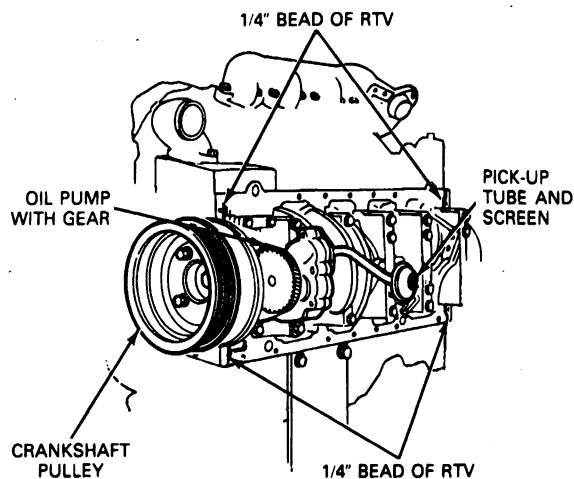
A7358-1B

7. Apply Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent on engine block and front cover sealing surfaces.
8. Install gaskets on engine block.

NOTE: Silicone Rubber Sealant should be applied immediately prior to front cover installation. When applying Silicone Rubber Sealant, always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to set-up and sealing effectiveness may be reduced.

REMOVAL AND INSTALLATION (Continued)

9. Apply a 3.2mm (1/8-inch) bead of Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A) or equivalent to rear corners of oil pan and apply a 6.4mm (1/4-inch) bead of Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A) or equivalent on oil pan as shown, for in-vehicle repair.



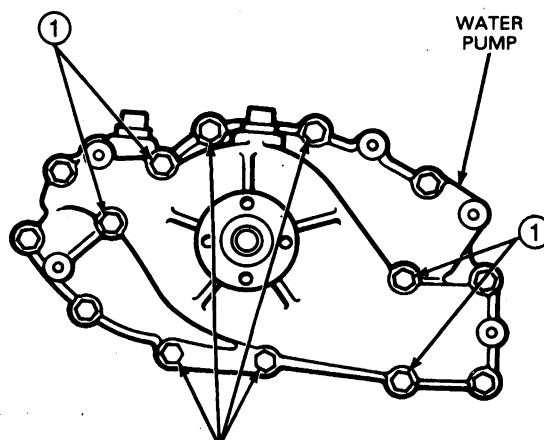
10. Install engine front cover in position, on oil pan dowels first, and install three attaching bolts as shown previously.
11. For in-vehicle repair, remove engine front cover alignment dowels from engine and oil pan. Install and hand-tighten remaining front cover bolts.
12. Install fabricated alignment dowels in engine block, if necessary.

13. Install water pump gasket on engine front cover alignment dowels.

NOTE: Apply Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent to four bolts as shown in following illustration.

14. Install water pump and hand tighten bolts.

Water Pump



APPLY AVIATION PERMATEX™ NO. 3 OR EQUIVALENT TO THESE BOLTS

- ① THESE BOLTS ARE 2 3/4-INCHES LONG. ALL OTHERS ARE 1 1/2 INCHES LONG.

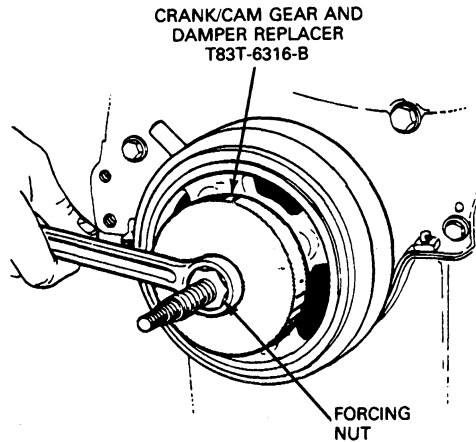
A7353-F

15. Remove alignment dowels and install two remaining attaching bolts.
- Tighten all water pump bolts to 19 N·m (14 ft·lb).
16. Tighten engine front cover bolts to standard torque specifications, see chart at end of this section.
17. Install injection pump adapter, as outlined in this section.
18. Install injection pump, as outlined in this section.
19. Install heater hose fitting in pump using Pipe Sealant With Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent.
20. Connect heater hose to water pump and tighten clamp to specification.
21. Raise vehicle.

NOTE: Add Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) to engine side of retaining bolt washer to prevent oil leakage past keyway.

REMOVAL AND INSTALLATION (Continued)

22. Lubricate damper seal nose with clean engine oil and install crankshaft vibration damper, using Crank / Cam Gear and Damper Replacer T83T-6316-B.



A10728-1A

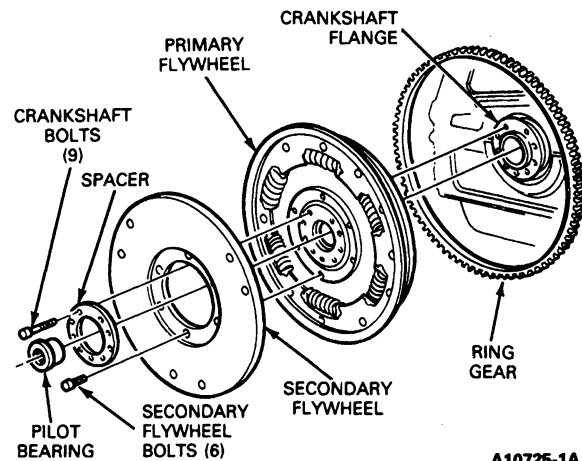
23. Install vibration damper-to-crankshaft attaching bolt and tighten to 122 N·m (90 ft·lb).
24. Install crankshaft pulley and tighten to standard torque specifications, see chart at end of this section.
25. Install both battery ground cables on front of engine.
26. Lower vehicle.
27. Install alternator bracket and tighten to 54-75 N·m (40-55 ft·lb).
28. Install water pump pulley and tighten to standard torque specification, see chart at end of this section.
29. Install accessory drive belt.
30. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B. Tighten to 54-163 N·m (40-120 ft·lb).
31. Install radiator fan shroud. Tighten bolts to 4-8 N·m (35-71 in·lb).
32. Remove turbocharger compressor opening cover. Install air cleaner assembly. Refer to Section 03-12, Air Intake, in this supplement and the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
33. Connect ground cables to both batteries.

34. Fill and bleed cooling system. Refer to Section 03-03, Engine Cooling, in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
35. Operate engine and inspect for coolant and oil leaks.

Flywheel, Engine Rear Cover and Oil Seal Removal**TOOLS REQUIRED**

Description	Tool Number
Rear Crankshaft Seal Pilot	T83T-6701-B

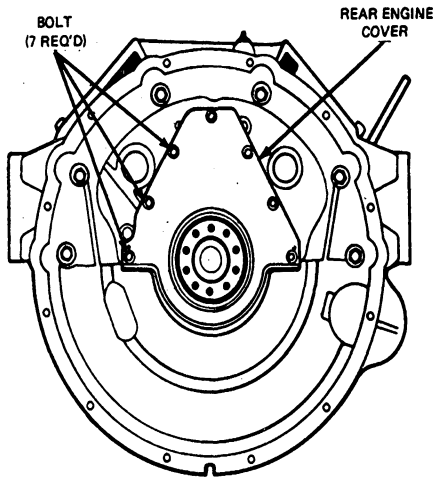
1. Loosen marman clamp at turbocharger exhaust charge pipe.
2. Raise vehicle.
3. Remove exhaust charge pipe.
4. Remove transmission and integral clutch housing (manual transmission). Remove clutch and clutch housing, if so equipped. Refer to Group 07 or Group 08, in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
5. Remove nine flywheel mounting bolts and spacer and remove flywheel.

Dual Mass Flywheel

A10725-1A

REMOVAL AND INSTALLATION (Continued)

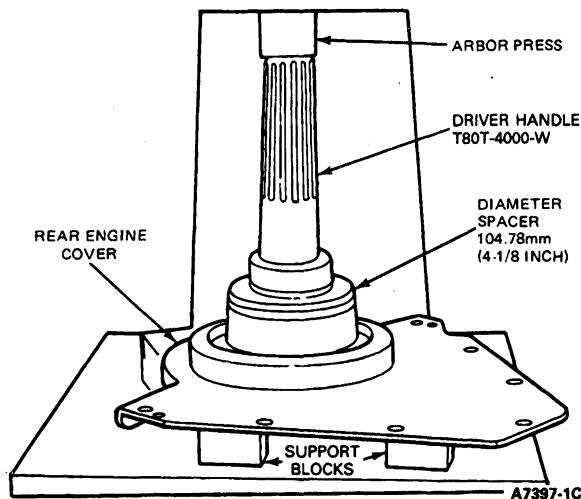
6. Remove bolts attaching rear engine cover to engine block and remove rear cover.



A7895-1A

NOTE: Support rear cover.

7. Using an arbor press and a suitable spacer 104.78mm (4-1/8-inch) diameter, remove rear oil seal.



A7397-1C

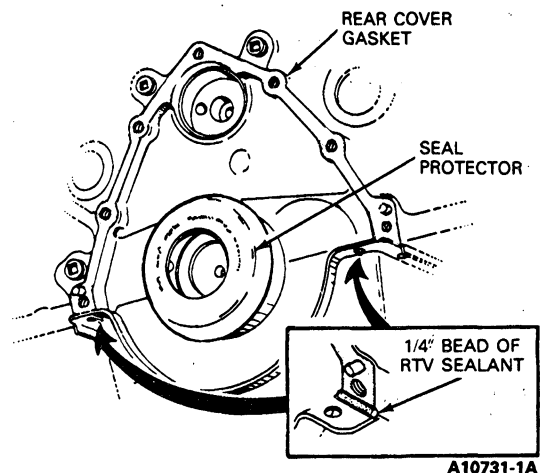
If rear cover seal fails repeatedly, check rear cover bore concentricity as follows:

- Install rear cover to engine with oil seal removed.
- Mount a dial indicator (on swivel joint) onto the crankshaft flange. Position the dial indicator press against the inside diameter of the rear cover seal bore.
- Measure at four equally spaced locations.
- Rear cover seal bore will be connected to the crankshaft centerline in accordance with specifications.
- Replace rear cover if not within 0.05mm (0.020 inch).

Installation

NOTE: When applying Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to set-up and sealing effectiveness may be reduced.

1. Clean rear cover and engine block gasket surfaces.
 2. Remove old RTV sealant from oil pan to rear cover sealing surface on oil pan. Clean sealing surfaces with a suitable solvent, and dry thoroughly.
 3. Coat rear engine cover seal bore inside diameter with Gasket and Trim Adhesive D7AZ-19B508-AA (ESR-M11P17-A) or equivalent.
- NOTE: Seal must be installed from the engine block side of rear cover flush with seal bore inner surface.
4. Use an arbor press and Rear Crankshaft Seal Replacer T83T-6701-A to install new rear main oil seal.
 5. Apply a 3.2mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent around the outside diameter of the rear seal and the edge of the rear cover.
 6. Install Rear Crankshaft Seal Pilot T83T-6701-B onto crankshaft.
 7. Apply Gasket and Trim Adhesive D7AZ-19B508-AA (ESR-M11P17-A) or equivalent to engine block and rear cover gasket surfaces.
 8. Install rear cover gasket to engine block.



A10731-1A

REMOVAL AND INSTALLATION (Continued)

NOTE: The dual mass flywheel may create an objectionable noise or vibration. Install new flywheel bolts with pre-applied adhesive (E7TZ-6379-B). When installing these bolts for the first time, do not apply additional adhesive to the threads. Each time this new bolt or previous bolt (without pre-applied adhesive) is removed to service the flywheel, clean the bolt threads and apply Threadlock 262 (E2FZ-19954-B) to the threads.

9. For in-vehicle repair, apply a 6.35mm (1/4-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent at the corners of the oil pan and on oil pan sealing surface.
10. Push rear cover into position on engine block and install attaching bolts. Remove Seal Pilot T83T-6701-B. Tighten all bolts to standard torque specification, see chart at the end of this section.
11. Position flywheel on crankshaft flange. Coat threads of flywheel attaching bolts with Perfect Seal Sealing Compound B5A-19554-A (ESE-M4G115-A) or equivalent and install spacer, bolts and washers (with flexplate, if so equipped). Tighten bolts to $64 \text{ N}\cdot\text{m} + 45^\circ$ ($47 \text{ ft}\cdot\text{lb} + 45^\circ$), alternating across from each other.
12. Install clutch, if so equipped. Refer to Group 08, in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
13. Install turbocharger exhaust charge pipe.
14. Install transmission. Refer to Group 07 or Group 08 in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
15. Lower vehicle.
16. Install and tighten exhaust charge pipe marman clamp to $8\text{-}9 \text{ N}\cdot\text{m}$ ($70\text{-}80 \text{ in}\cdot\text{lb}$).
17. Run engine and check for oil leaks.

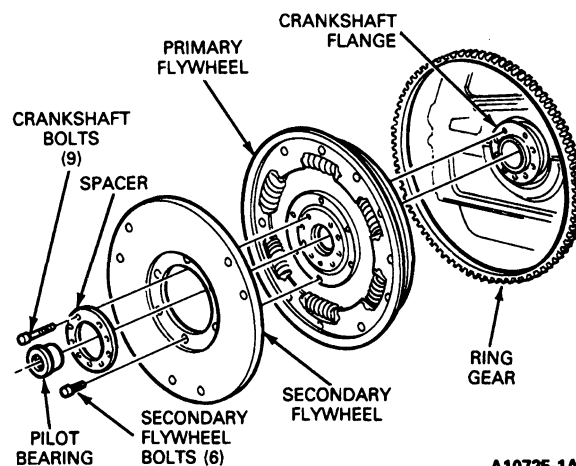
Secondary Flywheel

Removal

NOTE: The secondary flywheel inertia mass contains the clutch friction surface. Excessive clutch slipping can result in warpage or other surface distress which requires refacing or replacement of the secondary flywheel. Refer to Cleaning and Inspection in this section. The back side of the secondary flywheel contains a friction surface which is used in the internal torque limitation system of the dual mass flywheel assembly.

1. Remove the transmission, clutch pressure plate, and disc as outlined in Group 07 and Group 08 of the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
2. Remove six bolts retaining the secondary flywheel to the primary flywheel assembly. Do not permit the flywheel to fall from the vehicle.

3. Using a screwdriver or other suitable tool, pry the secondary flywheel off of its mounting pilot. Do not drop.



A10725-1A

Installation

1. Clean the clutch friction surface and torque limitation friction surface with a suitable commercial alcohol-based solvent to be sure that surfaces are free from any oil film.
2. Position secondary flywheel onto its mounting pilot on the primary flywheel assembly and align the six secondary flywheel attaching bolt holes with the six threaded holes of the primary flywheel assembly.
3. Clean the flywheel bolt threads and coat threads of secondary flywheel attaching bolts with Threadlock 262 (E2FZ-19954-B) and install bolts. Tighten bolts to $64 \text{ N}\cdot\text{m} + 45^\circ$ ($47 \text{ ft}\cdot\text{lb} + 45^\circ$), alternating across from each other.
4. Install the clutch pressure plate, disc, and transmission as outlined in Group 07 and Group 08 of the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.

Flywheel Ring Gear (Dual Mass Flywheel Only)

Removal

1. Remove transmission. Remove the clutch housing. Refer to Group 07 and Group 08 in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
2. Remove flywheel as outlined.
3. To replace a damaged or worn ring gear, heat the ring gear with a blow torch on the engine side of the gear, and knock it off the flywheel. **Do not hit the flywheel when removing the ring gear.**

REMOVAL AND INSTALLATION (Continued)

Installation

1. Heat the new ring gear evenly until the gear expands enough to slip onto the flywheel. Make sure the gear is seated properly against the shoulder. **Do not heat any portion of the gear to a temperature higher than 278°C (500°F). If this limit is exceeded, the hardness will be removed from the ring gear teeth.**
2. Install flywheel as outlined.
3. Install clutch housing and transmission. Refer to Group 07 and Group 08 in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.

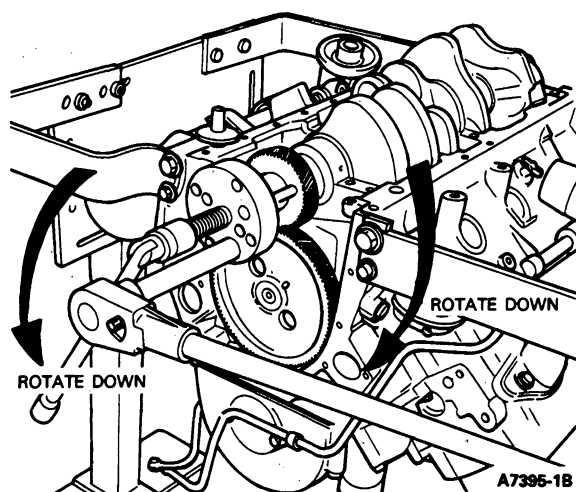
Crankshaft Drive Gear

TOOLS REQUIRED

Description	Tool Number
Crank / Cam Gear and Damper Remover	T83T-6316-A
Flywheel Holding Tool	T74P-6375-A
Crank / Cam Gear and Damper Replacer	T83T-6316-B

Removal

1. Remove engine front cover, as outlined in this section.
2. Install Crank / Cam Gear and Damper Remover T83T-6316-A. Using a breaker bar (in-vehicle procedure) to prevent crankshaft rotation or Flywheel Holding Tool T74P-6375-A (bench procedure), remove crankshaft gear.

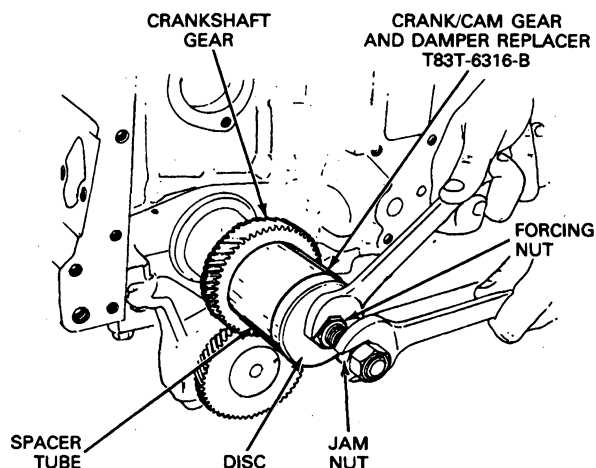


Installation

NOTE: Gear may be heated to 149-177°C (300-350°F) for ease of installation. Heat in oven. Do not use torch.

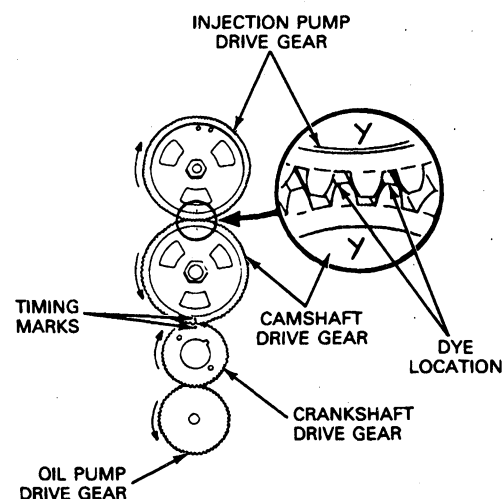
1. Install crankshaft gear using Crank / Cam Gear and Damper Replacer T83T-6316-B. Align crankshaft drive gear timing mark with crankshaft drive gear timing mark.

2. Install engine front cover as outlined in this section.



A10732-1A

Aligning Timing Marks



A10733-1A

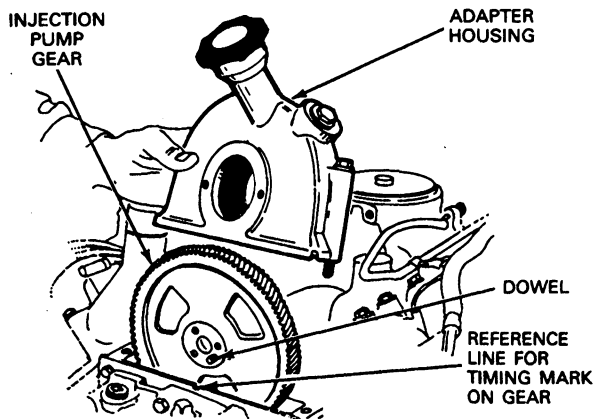
Injection Pump Drive Gear and Gear Cover

Removal

1. Disconnect ground cables from both batteries.
2. Remove air cleaner housing assembly.
3. Remove injection pump as described in this section.
4. Remove bolts attaching injection pump drive gear cover to engine block, and remove cover.
 - Do not remove drive gear yet.

REMOVAL AND INSTALLATION (Continued)

Drive Gear Cover



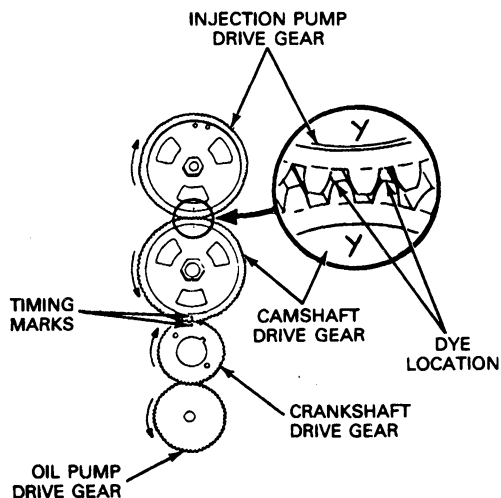
A10734-1A

5. Remove glow plugs with Glow Plug Socket D83T-6002-A or equivalent to facilitate turning engine over by hand.

NOTE: To determine that No. 1 piston is at TDC (compression stroke), position injection pump drive gear dowel at the four o'clock position. The scribe line in vibration damper should be at TDC.

NOTE: To aid aligning the timing marks, the pump drive gear and the camshaft gear are marked with "Y" timing marks. The crankshaft and camshaft gears are marked with "o" (dot) alignment marks. With engine at TDC compression for No. 1 cylinder, the "Y" marks should be aligned.

6. Turn engine over by hand to TDC (top dead center), compression stroke of No. 1 piston.



A10733-1A

CAUTION: Do not remove injection pump gear without performing the following procedure.

7. Slide injection pump gear back (do not remove) to expose top of camshaft gear when looking down into the front cover. In addition to the "Y", the gear teeth adjacent to the "Y" on the camshaft gear are permanently dyed.

8. Remove injection pump drive gear.

Installation

1. Clean all gasket and sealing surfaces with a suitable solvent and dry thoroughly.

NOTE: To determine that No. 1 piston is at TDC of compression stroke, position injection pump drive gear dowel at the four o'clock position. The scribe line in vibration damper should be at TDC.

CAUTION: Use extreme care to avoid disturbing injection pump drive gear, once it is in position.

2. With drawn line on drive gear at six o'clock position, install gear and align all drive gear timing marks.

NOTE: When applying Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent always use the bead size specified and join the components within 15 minutes of application. After 15 minutes, sealant begins to set-up and sealing effectiveness may be reduced.

3. Apply a 3.16mm (1/8 inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent along bottom surface of injection pump drive gear cover.
4. Install injection pump drive gear cover and tighten retaining bolts to 19 N·m (14 ft·lb). Apply Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent to bolt threads before assembly.

- With injection pump drive gear cover installed, the injection pump drive gear cannot "jump" timing.

5. Install air cleaner housing assembly, refer to Section 03-12 in this Supplement.
6. Install glow plugs as outlined in this section.
7. Install ground cables to both batteries.

WARNING: KEEP EYES AND HANDS AWAY FROM NOZZLE SPRAY. FUEL SPRAYING FROM THE NOZZLE UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.

8. Run engine and check for oil, fuel and coolant leaks.
9. Purge high-pressure fuel lines of air if necessary, by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.

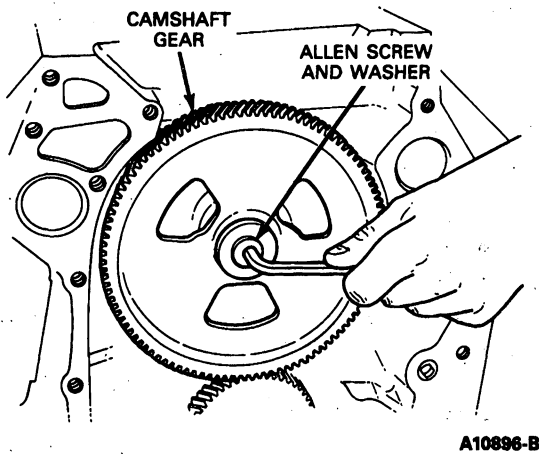
REMOVAL AND INSTALLATION (Continued)

Camshaft Drive Gear, Fuel Pump Cam, Spacer and Thrust Plate**TOOLS REQUIRED**

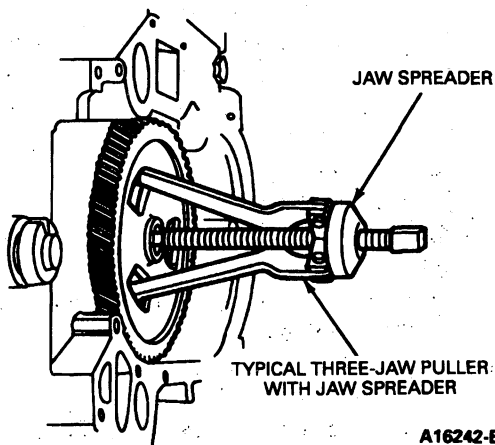
Description	Tool Number
Gear Puller	T77F-4220-B1
Crank / Cam Gear and Damper Replacer	T83T-6316-B

Removal

1. Remove engine front cover, as outlined in this section.
2. Remove camshaft Allen screw and washer.

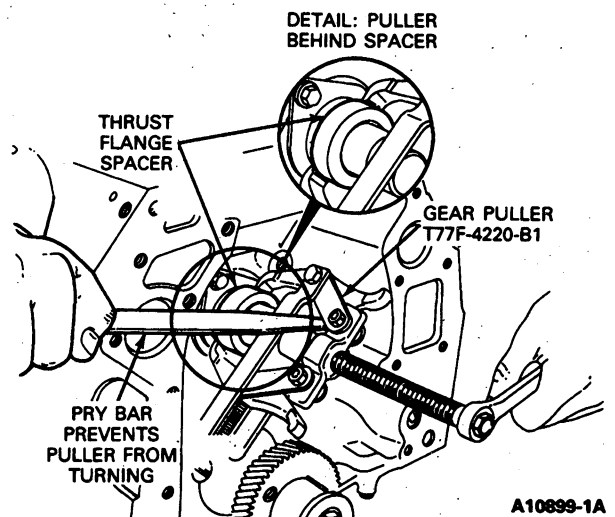
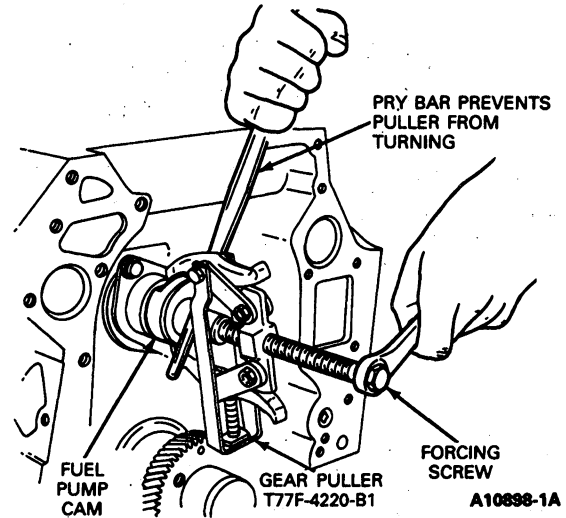


3. Install three-jaw gear puller and remove gear.



4. If necessary, remove fuel supply pump as outlined in this section.

5. Install Gear Puller T77F-4220-B1 and remove fuel pump cam and thrust flange spacer, if necessary.



6. Remove bolts attaching thrust plate. Remove thrust plate, if necessary.

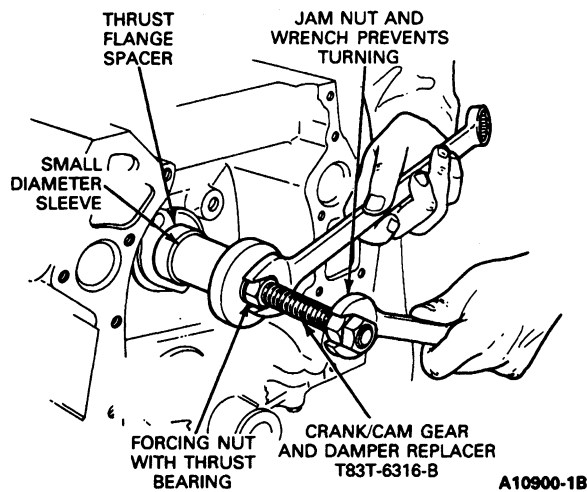
Installation

NOTE: Replace fuel supply pump cam if nicked, scored, or otherwise damaged. If fuel supply pump cam is replaced, inspect fuel supply pump.

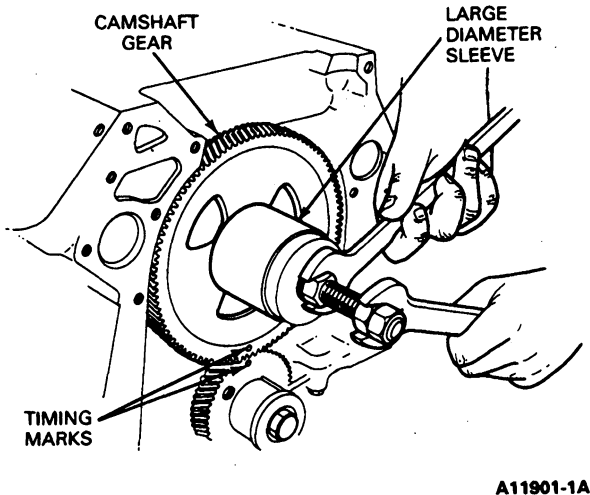
1. Install new thrust plate, if removed, and tighten to specification.

REMOVAL AND INSTALLATION (Continued)

2. Install spacer and fuel supply pump cam against camshaft thrust flange using Crank / Cam Gear and Damper Replacer T83T-6316-B if removed.



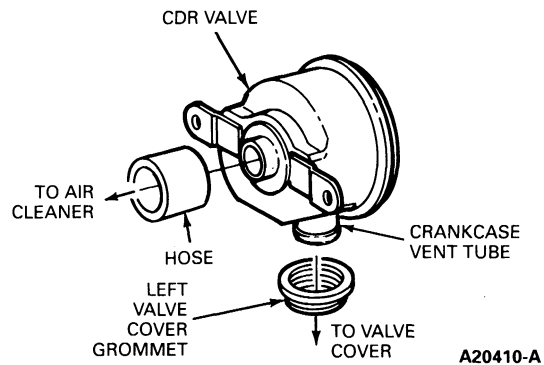
3. Install camshaft drive gear against fuel supply pump cam, aligning timing mark with mark on crankshaft drive gear, using Crank / Cam Gear and Damper Replacer T83T-6316-B.



4. Install camshaft Allen screw and tighten to 20 N·m (15 ft-lb).
5. Install fuel supply pump as outlined in this section.
6. Install new crankshaft oil seal in engine front cover, as outlined.
7. Install engine front cover, as outlined.

Crankcase Depression Regulator (CDR)**Removal and Installation**

1. Remove two bolts attaching CDR valve to valve cover and CDR hose clamp and remove valve.



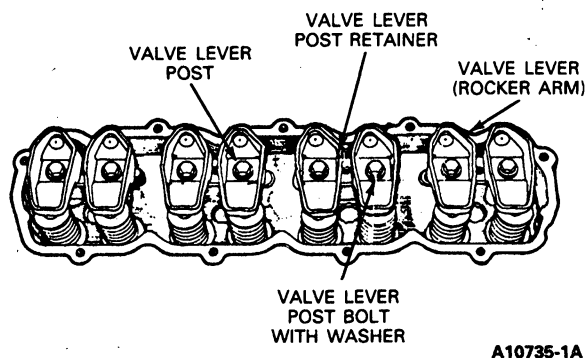
For installation, follow removal procedures in reverse order.

Valve Cover, Rocker Arm, and Push Rod**Removal**

1. Disconnect ground cables from both batteries.
2. Remove transmission filler tube fasteners and rotate filler tube and dipstick aside. (Right valve cover only).
3. Remove engine oil dipstick tube fasteners and remove dipstick tube assembly and bracket (right side only).
4. Remove CDR valve attaching bolts and position aside (left valve cover only).
5. Remove glow plug protective cover (right valve cover only).
6. Remove electrical connectors from glow plug controller (right valve cover only).
7. Remove glow plug controller retaining bolts and glow plug controller (right valve cover only).
8. Remove accessory drive belt (right valve cover only).
9. Disconnect alternator electrical connectors (right valve cover only).
10. Disconnect fuel lines from fuel filter assembly (right valve cover only).
11. Remove alternator bracket retaining bolts (right valve cover only).
12. Remove alternator bracket assembly (right valve cover only).
13. Remove valve cover attaching screws and remove covers.

REMOVAL AND INSTALLATION (Continued)

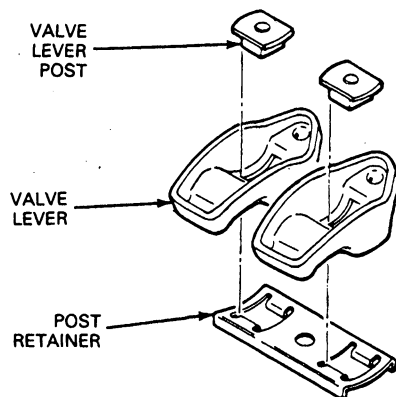
14. Remove valve rocker arm post mounting bolts.



15. Remove valve rocker arms and posts in order and identify so they are returned to their original positions.

- It is not necessary to disassemble the rocker arms from their pedestal assemblies to inspect them. Inspect rocker arms by rotating to the maximum position and view the post area from the underside.

16. Remove push rods in order and identify so they are returned to their original positions.



A10736-1A

Installation

NOTE: Install copper colored end of push rod toward rocker arm.

- Install push rods in their original positions, making sure they are fully seated in tappet push rod seats.
- Install valve rocker arms and posts in their original positions. Apply Multi-Purpose grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to valve stem tips.
- Install valve rocker arm post attaching bolts as follows:
 - Turn engine over by hand until timing mark is at 11:00 o'clock position as viewed from front of engine.
 - Install all rocker arm post attaching bolts, and tighten to 27 N·m (20 ft-lb).

- Clean valve covers with clean solvent and install new gaskets.
- Install valve covers on cylinder heads. Tighten attaching screws to 8 N·m (6 ft-lb).
- Install alternator bracket assembly (right valve cover only).
- Install alternator bracket retaining bolts (right valve cover only). Tighten retaining bolts. Refer to the standard torque chart at the end of this section.
- Connect fuel lines to fuel filter assembly (right valve cover only).
- Connect electrical connectors to alternator (right valve cover only).
- Install accessory drive belt (right valve cover only).
- Install glow plug controller and retaining bolts (right valve cover only).
- Install electrical connectors to glow plug controller (right valve cover only).
- Install glow plug controller protective cover (right valve cover only).
- Install CDR valve and attaching bolt (left valve cover only).
- Install transmission filler tube nut and tighten to specification. Install transmission oil dipstick, if required.
- Install engine oil dipstick tube, bracket and fasteners (right side only).
- Install ground cables to both batteries.
- Run engine and inspect for oil leaks.

Valve Spring, Retainer and Stem Seal

Broken valve springs or damaged valve stem seals and retainers may be replaced without removing the cylinder head, provided damage to the valve or valve seat has not occurred. Refer to the following procedure.

TOOLS REQUIRED

Description	Tool Number
Spring Compressor	T83T-6513-A
Valve Stem Seal Replacer	T83T-6571-A

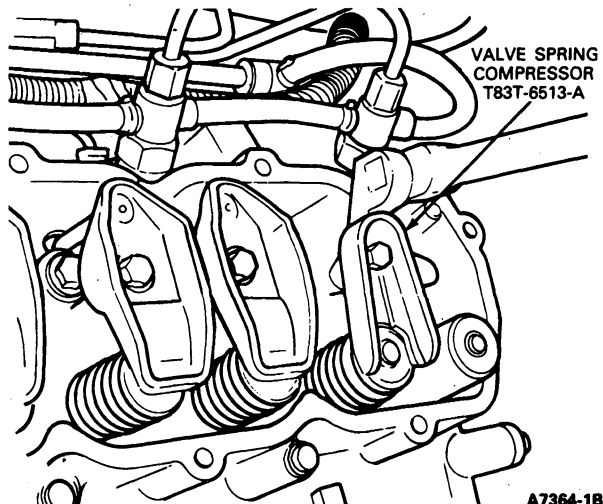
Removal

- Remove the required valve rocker arm(s).
- Remove glow plug(s) with Glow Plug Socket D83T-6002-A or equivalent.
- Install an air line with the adapter from Rotunda Compression Tester 014-00701 or equivalent into the glow plug hole and turn on the air supply.

NOTE: It may be necessary to strike valve stem end with a plastic-tipped hammer to loosen valve retainer locks.

REMOVAL AND INSTALLATION (Continued)

4. Install Spring Compressor T83T-6513-A as shown. Compress valve spring and remove retainer locks, oil shield spring retainer, valve spring and damper spring.



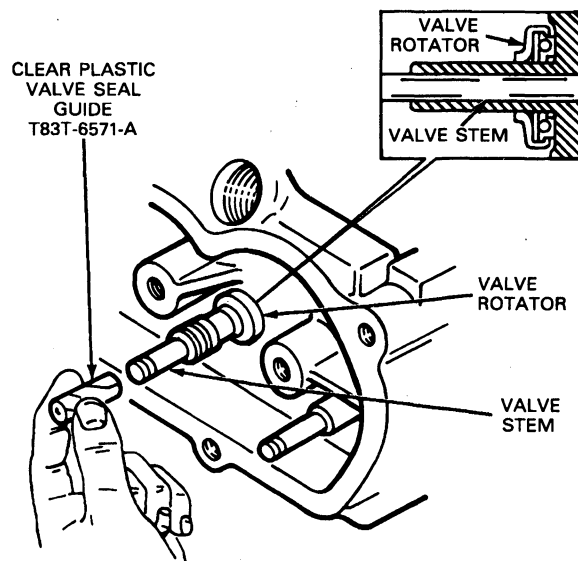
5. Remove valve stem seal and valve rotators.
6. Air pressure will force the piston to bottom of the cylinder and any removal of air pressure will allow valve(s) to fall into cylinder. A rubber band, tape or string wrapped around end of valve stem will prevent this condition and will still allow enough travel to check the valve for binding.

Installation

NOTE: When installing a new valve, always use new retainer locks.

1. Inspect cylinder head and valve assemblies, as outlined. Inspect the valve stem for damage. Rotate the valve and check valve stem tip for eccentric movement during rotation. Move valve up and down through normal travel in valve guide and check stem for binds.
 - If valve has been damaged, it will be necessary to remove cylinder head for repairs. Inspect valve retainer locks for excessive wear, and replace in pairs, as necessary.

2. If condition of valve proved satisfactory, hold valve in closed position and pressurize cylinder by applying compressed air to adapter installed in glow plug hole.
3. Lubricate valve stem with recommended engine oil.
4. Install valve rotators as shown.

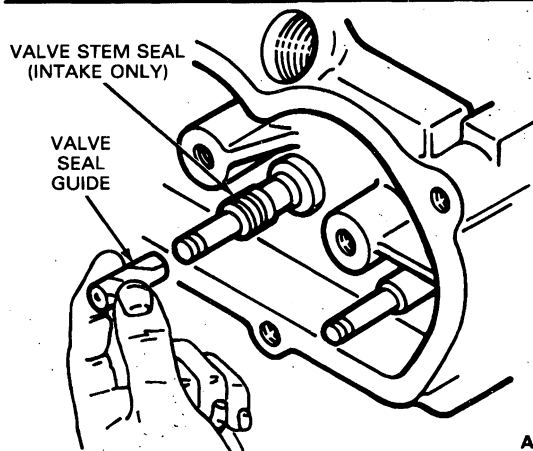
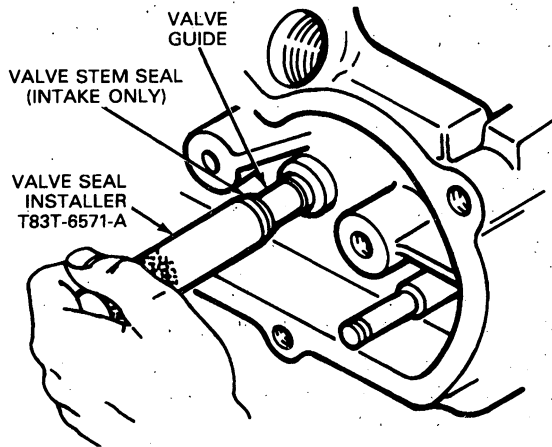


CAUTION: Apply only steady hand pressure on Valve Stem Seal Replacer T83T-6571-A until the seal bottoms squarely on the valve guide.

REMOVAL AND INSTALLATION (Continued)

5. For the intake valves only, install valve stem seals by installing the clear plastic valve seal guide. Install the valve stem seal by hand until it rests on the end of the valve guide.

- Use Valve Stem Seal Replacer T83T-6571-A to align the seal over the end of the valve guide as shown.



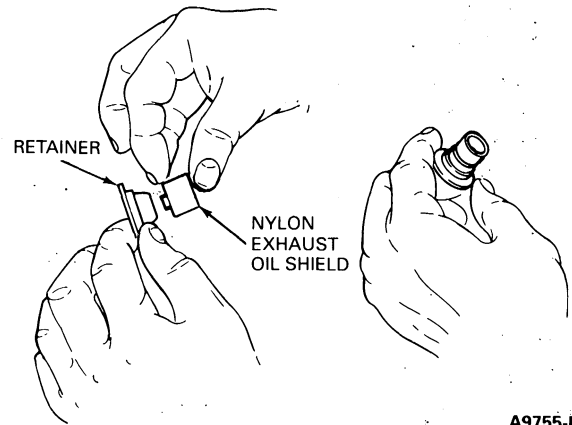
A9754-C

CAUTION: If the nylon oil shield is not properly installed in the exhaust valve spring retainer, it will float and cause excessive oil consumption.

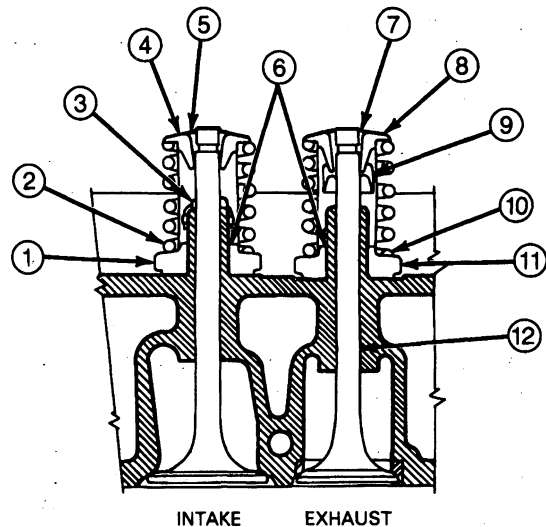
NOTE: Starting with engine number 520429, intake valve oil shield has been eliminated for both production and service gasket sets. Also, a new, larger oil shield is supplied for exhaust valves.

NOTE: Intake and exhaust valve stem oil shields are different. The intake valve oil shield is much smaller than the exhaust valve oil shield. These oil shields are not interchangeable.

6. Remove the plastic valve seal guide. Install the nylon oil shield into the exhaust valve spring retainer, applying pressure on shield until it snaps into place.



A9755-B



A15993-A

Item	Part Number	Description
1	6K533	Valve Rotator
2	6513	Spring with Damper
3	6571	Valve Stem Seal (Intake Only)
4	6514	Retainer
5	6518	Retainer Lock
6	6510	Valve Guide
7	6514	Retainer Lock
8	6518	Retainer
9	6517	Oil Shield (Exhaust Only)
10	6513	Spring with Damper
11	6K533	Valve Rotator
12	—	Valve Guide Bore

7. Place spring in position over valve and install valve spring retainer assembly. Compress valve spring and install valve spring retainer locks. Verify that the locks are correctly seated. Remove valve spring compressor.

REMOVAL AND INSTALLATION (Continued)

8. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to tips of valve stem and push rods.
9. Install required rocker arm(s) and push rod(s) following instructions under Rocker Arm Installation.
10. Install glow plugs using Glow Plug Socket D83T-6002-A or equivalent and tighten to 16 N·m (12 ft·lb).

Fuel Supply Pump**Removal****WARNING: USE CARE TO PREVENT COMBUSTION OF SPILLED FUEL.**

1. Loosen threaded connections with proper size wrench (flare nut wrench preferred) and tighten snugly. Do not remove lines at this time.
2. Loosen mounting bolts one to two turns. Apply force with hand to loosen fuel pump if gasket is stuck. Rotate engine, by "nudging" starter, until fuel pump cam lobe is at low position. At this position, spring tension against fuel pump bolts will be greatly reduced.
3. Disconnect fuel supply pump inlet, outlet and fuel return lines.
4. Remove fuel pump attaching bolts. Remove pump and gasket. Discard old gasket.

Installation

1. Remove all fuel pump gasket material from engine and from fuel supply pump if installing original pump.

NOTE: Cam must be at low position before attempting to install fuel supply pump. If it is difficult to start the mounting bolts due to spring action of the fuel pump, turn crankshaft by hand 360 degrees to relocate camshaft lobe. Then, proceed with fuel supply pump installation. Install with lever on bottom side of cam.

2. Install attaching bolts into fuel supply pump and install a new gasket onto bolts. Position fuel supply pump to mounting pad. Turn attaching bolts alternately and evenly. Refer to Standard Torque Specification Chart at the end of this section.
3. Install fuel outlet line. Start fitting by hand to avoid crossthreading. Tighten to 20-24 N·m (15-18 ft·lb).
4. Install inlet line and tighten hose clamp to specification.
5. Start engine and observe all connections for fuel leaks for two minutes.
6. Stop engine and check all fuel supply pump fuel line connections. Check for oil leaks at pump mounting pad.

Injection Pump**TOOLS REQUIRED**

Description	Tool Number
Fuel System Protector Cap Set	T83T-9395-A
Injection Pump Mounting Wrench	T86T-9000-B
Fuel Line Nut Wrench	T83T-9396-A

NOTE: Before removing any fuel lines, clean exterior with clean fuel oil or solvent to prevent entry of dirt into engine when fuel lines are removed.

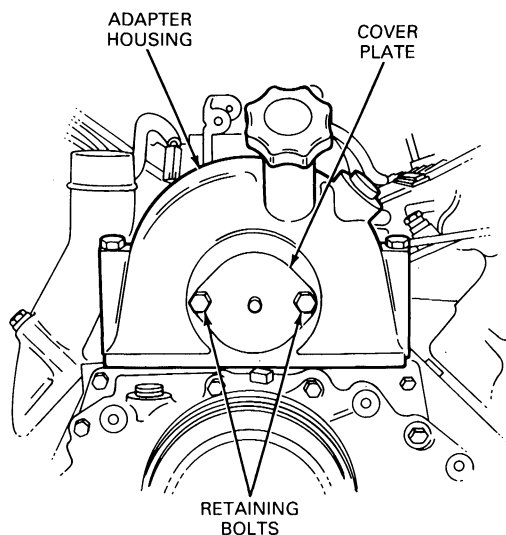
NOTE: The turbo diesel engine has a different flow-rated injection pump than the naturally-aspirated version, even though they are the same model number. When replacing the pump make sure the correct replacement part is used or poor engine performance will be observed.

CAUTION: Do not wash or steam clean engine while engine is running or still hot from running. Serious damage to injection pump could occur.

CAUTION: Do not carry injection pump by injection nozzle fuel lines as this could cause lines to bend or crimp.

Removal

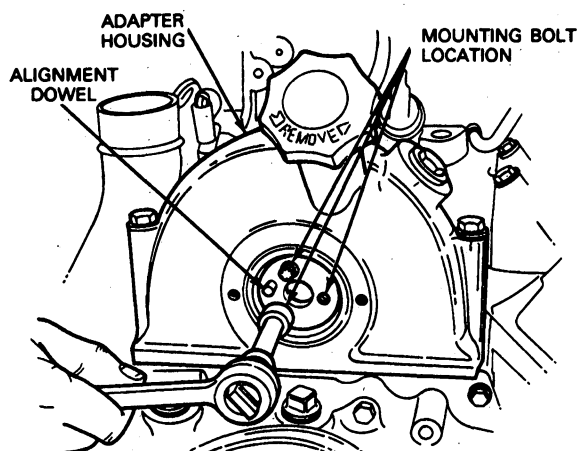
1. Disconnect battery ground cables from both batteries.
2. Remove adapter housing cover plate by removing two retaining bolts.



A10895-B

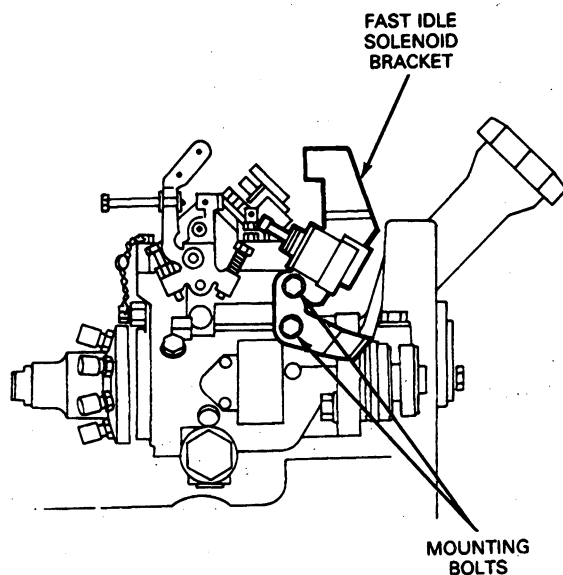
REMOVAL AND INSTALLATION (Continued)

3. Remove bolts attaching injection pump to drive gear.



A11903-1B

4. Disconnect electrical connectors to injection pump.
5. Remove fast idle solenoid bracket assembly to provide access to injection pump mounting nuts.



RIGHT SIDE VIEW

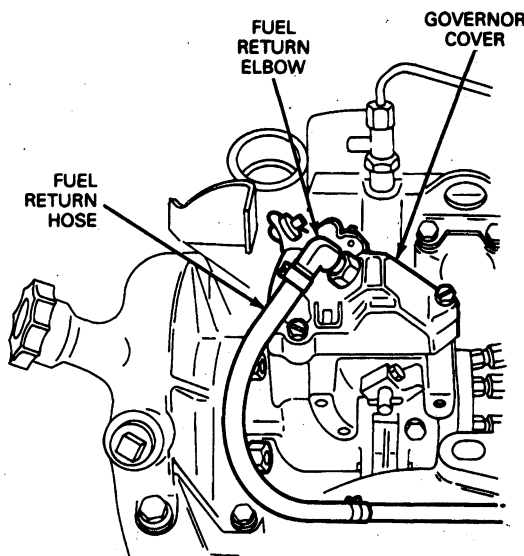
A11904-1A

6. Disconnect accelerator cable and speed control cable from throttle lever, if so equipped.

7. Remove air cleaner housing assembly.
8. Remove accelerator cable bracket (with cables attached) from intake manifold and position out of the way.

NOTE: All fuel lines and fittings must be capped using Fuel System Protector Cap Set T83T-9395-A to prevent fuel contamination.

9. Remove fuel return hose and clip from the 90 degree elbow at the governor cover. Cap opening at governor cover elbow.

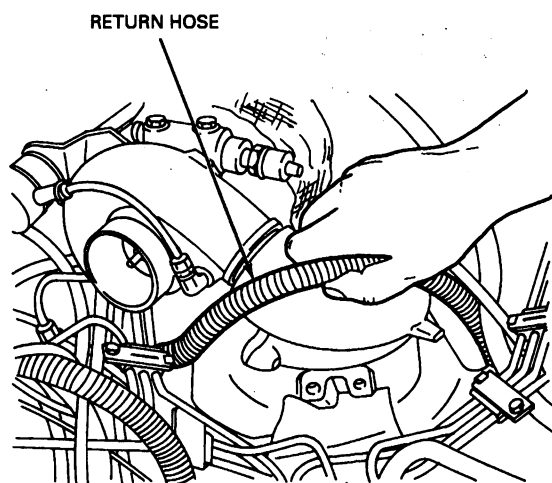


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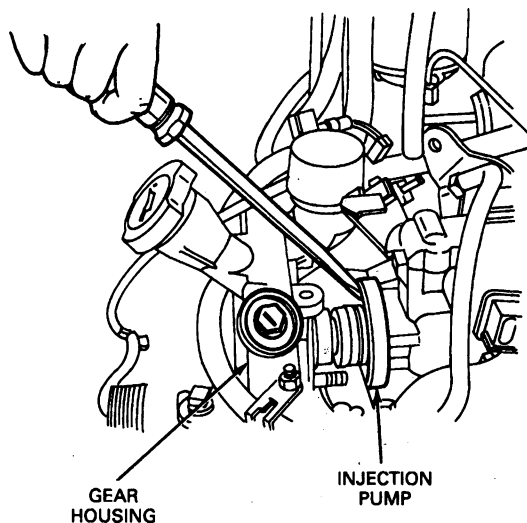
10. Remove fuel filter-to-injection pump fuel line and cap fittings.
11. Remove fuel injection lines from nozzles and cap lines and nozzles.
12. Loosen injection line retaining clips and remove injection nozzle fuel lines with Fuel Line Nut Wrench T83T-9396-A. Cap all fittings at this time with Fuel System Protector Cap Set T83T-9395-A. Do not install injection nozzle fuel lines until new pump is installed in engine.
13. Remove three nuts attaching injection pump to injection pump drive gear cover using Injection Pump Mounting Wrench T86T-9000-B.

REMOVAL AND INSTALLATION (Continued)

14. Lift injection pump up and out of intake manifold valley, and remove assembly.



A20412-A



A20413-A

Injection Pump Removal, 7.3L IDI Turbo Diesel Engine, F-Series

ADAPTER HOUSING WITH
MOUNTING STUDS
(STUDS NOT SHOWN)



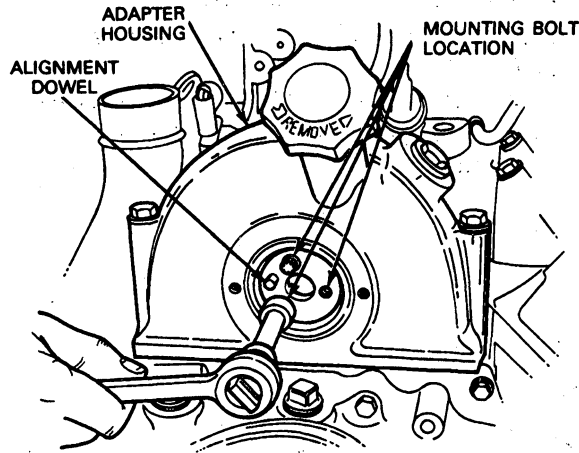
A11907-C

Installation

1. Install new O-ring onto drive gear end of injection pump.
2. Move injection pump down and into position. Set fuel return crossover hose in position.

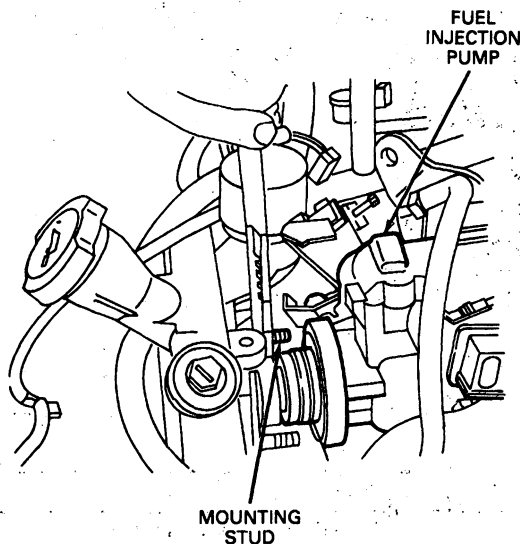
REMOVAL AND INSTALLATION (Continued)

3. Position alignment dowel on injection pump into alignment hole on drive gear. If necessary, rotate pump drive shaft to align drive slot prior to installation.



A11903-1B

4. Install bolts attaching injection pump to drive gear and tighten to 34 N·m (25 ft·lb).
5. Install nuts attaching injection pump to adapter. Align scribe lines on injection pump flange and injection pump adapter. Tighten nuts to 35 N·m (26 ft·lb) using injection pump mount wrench T86T-9000-B.



A20411-A

6. Install fuel lines to injection pump, using Fuel Line Nut Wrench T83T-9396-A and tighten to 30 N·m (22 ft·lb).
7. Remove caps from nozzles and fuel lines. Install fuel line nuts onto nozzles and tighten to 30 N·m (22 ft·lb) using Fuel Line Nut Wrench T83T-9396-A.
8. Remove caps and connect fuel filter-to-injection pump fuel line and tighten to specification listed at the end of this section.
9. Install accelerator cable bracket to intake manifold and tighten to 16-23 N·m (12-17 ft·lb).
10. Install air cleaner assembly. Refer to Section 03-12, Air Intake, in this Supplement.
11. Connect accelerator and speed control cable, if so equipped, to throttle lever.
12. Install fast idle solenoid bracket assembly and tighten to specification.
13. Install electrical connectors on injection pump.
14. Clean adapter housing cover plate sealing surfaces.

NOTE: When applying Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to set-up and sealing effectiveness may be reduced.

15. Apply a 3.2mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent in adapter housing grooves.
16. Connect ground cables to both batteries.

WARNING: KEEP EYES AND HANDS AWAY FROM FUEL SPRAY. FUEL SPRAYING FROM PARTIALLY OPENED CONNECTION UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.

17. Run engine and check for fuel leaks.
18. If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.
19. Check and adjust injection pump timing as described in Section 20A Diesel Diagnosis, 7.3L IDI Turbo Engine in this Supplement.

REMOVAL AND INSTALLATION (Continued)

Injection Nozzle Fuel Lines

TOOLS REQUIRED

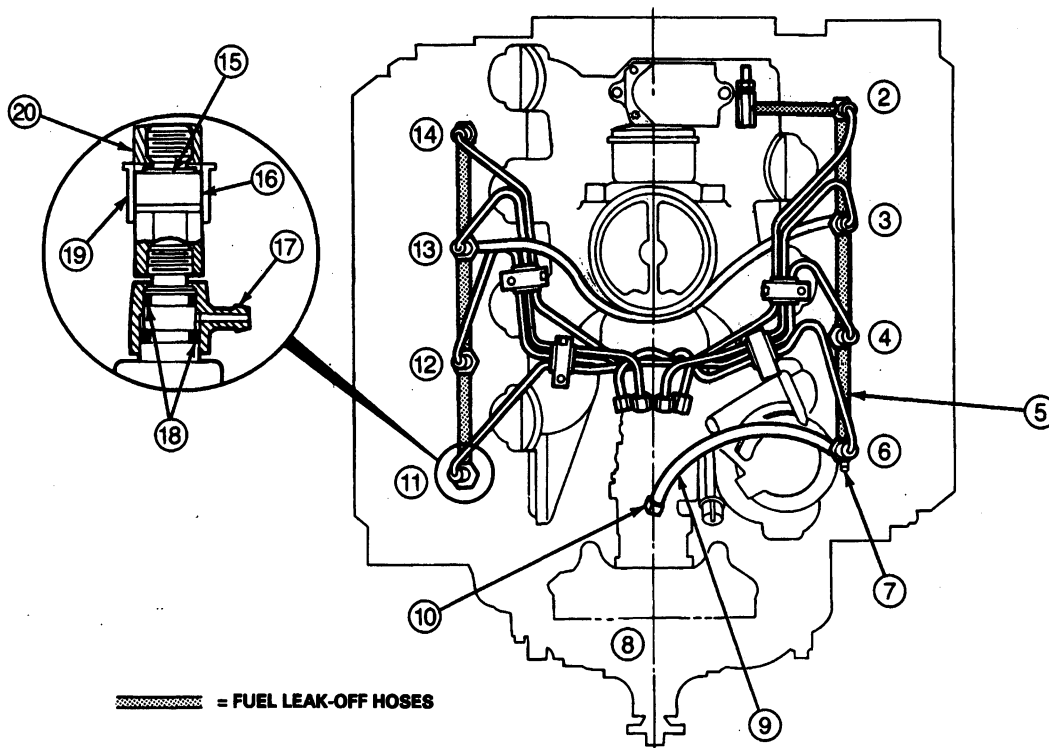
Description	Tool Number
Fuel System Protector Cap Set	T83T-9395-A
Fuel Line Nut Wrench	T83T-9396-A

Removal

NOTE: Before removing any fuel lines, clean exterior of each nozzle assembly and surrounding area with solvent to prevent entry of dirt into fuel system when fuel lines are removed. Blow dry with compressed air.

Fuel Line Routing and Installation

1. Disconnect ground cables from both batteries.
2. Remove air cleaner housing assembly.
NOTE: To prevent fuel system contamination, cap all fuel lines and fittings with Fuel System Protector Cap Set T83T-9395-A.
3. Disconnect fuel line from fuel filter to injection pump and cap all fittings.
4. Disconnect and cap nozzle fuel lines at nozzles.
5. Remove fuel line clamps from fuel lines to be removed.



A20414-A

Item	Description
1	Clamp
2	Cylinder 8
3	Cylinder 6
4	Cylinder 4
5	Fuel Return Tube
6	Cylinder 2
7	To Fuel Filter
8	Engine Centerline
9	Clip and Hose (Pump to Fuel Return Tube)

(Continued)

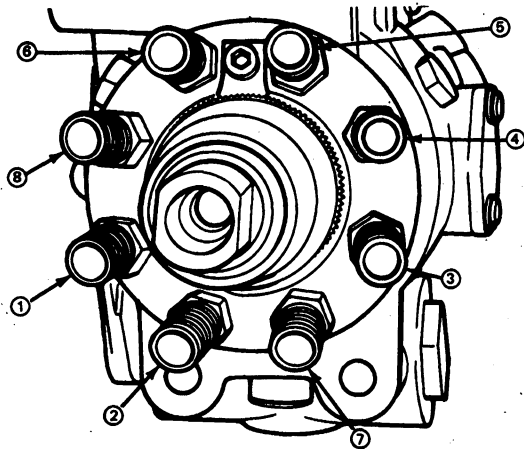
Item	Description
10	Fuel Return Elbow at Pump
11	Cylinder 1
12	Cylinder 3
13	Cylinder 5
14	Cylinder 7
15	Sensor (Install on Cylinder No. 1 Nozzle)
16	Line Pressure Sensor
17	Leak-Off Tee
18	O-Rings (2)
19	Sensor Cover
20	Injection Line Nut

REMOVAL AND INSTALLATION (Continued)

6. Remove and cap inlet fitting adapter.

NOTE: Fuel lines must be removed following this sequence: 5-6-4-8-3-1-7-2. Install caps on each end of each fuel line and pump fitting as it is removed and identify each fuel line accordingly.

7. Remove injection nozzle lines, one at a time, from injection pump using Fuel Line Nut Wrench T83T-9396-A.



CYLINDER NUMBER

A7370-1A

Installation

NOTE: Fuel lines must be installed in the following sequence: 2-7-1-3-8-4-6-5.

1. Install fuel lines on injection pump using Fuel Line Nut Wrench T83T-9396-A one at a time, and tighten to 30 N·m (22 ft-lb).
2. Remove caps from fuel lines and connect lines to nozzles. Tighten to 30 N·m (22 ft-lb) using Fuel Line Nut Wrench T83T-9396-A.
3. Uncap and connect fuel line from fuel filter to injection pump and tighten to 30 N·m (22 ft-lb).
4. Install fuel line retaining clamps and tighten to specification.
5. Install air cleaner housing assembly. Refer to Section 03-12, Air Intake, in this Supplement.
6. Connect ground cables to both batteries.
WARNING: KEEP EYES AND HANDS AWAY FROM FUEL SPRAY. FUEL SPRAYING FROM PARTIALLY OPENED CONNECTION UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.
7. Run engine and check for fuel leaks.
8. If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.

Injection Nozzles

TOOLS REQUIRED

Description	Tool Number
Fuel System Protector Cap Set	T83T-9395-A
O-Ring Tool	T71P-19703-C
Nozzle Seat Cleaner	T83T-9527-A
Fuel Line Nut Wrench	T83T-9396-A

Removal

NOTE: Before removing nozzle assemblies, clean exterior of each nozzle assembly and the surrounding area with solvent to prevent entry of dirt into engine when nozzle assemblies are removed. Also, clean fuel inlet and fuel leak-off piping connections. Blow dry with compressed air.

NOTE: The turbo diesel engine uses different flow-rated injection nozzles than the naturally-aspirated version. The turbo injection nozzles can be identified with a stamped code "G". When replacing the nozzles make sure the correct replacement part is used or poor engine performance will be observed.

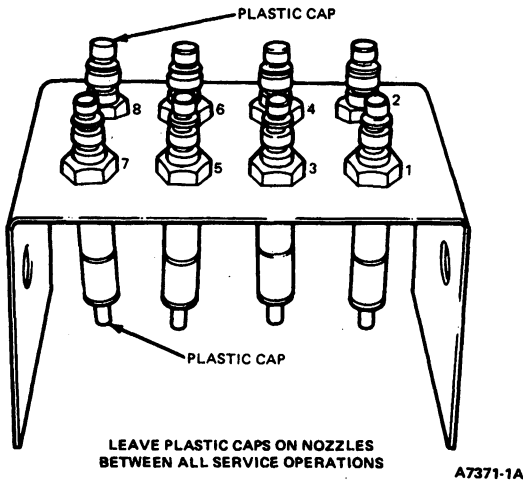
NOTE: On F-Series, remove and cap line sensor on No. 1 cylinder to permit removal of fuel leak-off tees.

1. Disconnect nozzle fuel inlet (high pressure) and fuel leak-off tees from each nozzle assembly and position out of the way. **Cover open ends of fuel inlet lines and nozzles to prevent contamination with Fuel System Protector Cap Set T83T-9395-A.**
2. Remove fuel leak-off lines as an assembly as follows.
 - a. Remove pump to fuel return tube hose at fuel return elbow. Cap elbow at pump. Disconnect hose (from leak-off tee to fuel filter) at leak-off tee.
 - b. With clamps removed, remove return lines and tees as an assembly by lifting tees off nozzles.
3. Remove injection nozzles by turning counterclockwise. Pull nozzle assembly with copper washer from engine. **Be careful not to strike nozzle tip against any hard surface during removal. Cover nozzle assembly fuel inlet opening and nozzle tip with plastic cap, Fuel System Protector Cap Set T83T-9395-A.**
4. Remove copper injector nozzle gasket from nozzle bore with O-Ring Tool T71P-19703-C if not attached to nozzle tip.

REMOVAL AND INSTALLATION (Continued)

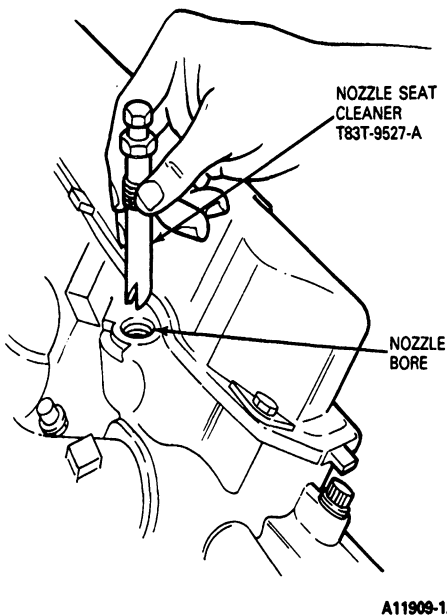
5. Place nozzle assemblies in a fabricated holder as they are removed from the heads. The holder should be marked with numbers corresponding to the cylinder numbering of the engine.

- Use of this holder permits nozzle installation into original location in the cylinder heads.



Installation

1. Thoroughly clean nozzle bore in cylinder head before reinserting nozzle assembly with Nozzle Seat Cleaner T83T-9527-A.
- Pay particular attention to seating surface, in order that no small particles of metal or carbon will cause assembly to be cocked or permit blow-by of combustion gases. Blow out particles with compressed air.



NOTE: Anti-seize compound or equivalent should be used on nozzle threads to aid installation and future removal.

2. Remove protective cap and install a new copper gasket on nozzle assembly with a small dab of Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent.

CAUTION: Be careful that nozzle tip does not strike against recess wall.

3. Install nozzle assembly into cylinder head nozzle bore.
4. Tighten nozzle assembly to 47 N·m (35 ft-lb).
5. Remove protective caps from nozzle assemblies and fuel lines.

NOTE: Install two new O-ring seals for each fuel return tee.

6. Install leak-off tees and lines as an assembly by lowering onto nozzles. Connect clip and hose to fuel return elbow at pump. Install line to retaining clamps.
7. Connect high pressure fuel line(s) and tighten to specification using Fuel Line Nut Wrench T83T-9396-A.

WARNING: KEEP EYES AND HANDS AWAY FROM FUEL SPRAY. FUEL SPRAYING FROM PARTIALLY OPENED CONNECTION UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.

8. Start engine.
9. If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.
10. Check for fuel leakage at high-pressure connections.

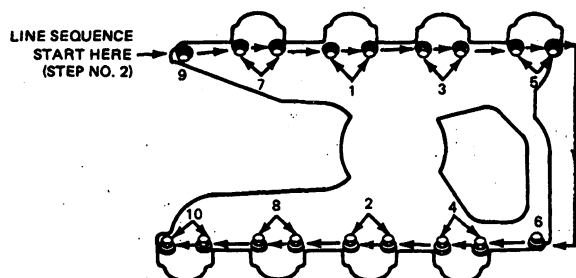
Intake Manifold, Valley Pan and Tappets

Removal

1. Disconnect ground cables from both batteries.
 2. Remove air cleaner and housing assembly.
 3. Remove turbocharger assembly. Refer to Section 03-12B in this Supplement.
 4. Remove injection pump, as outlined in this section.
 5. Remove fuel return hoses from No. 5 and No. 6 nozzles.
- NOTE:** Remove engine harness ground cable from back of right cylinder head.
6. Remove bolts attaching intake manifold to cylinder heads and remove manifold.

REMOVAL AND INSTALLATION (Continued)

Intake Manifold Attaching Bolts Tightening Sequence



STEP 1. TIGHTEN BOLTS TO 33 N·m (24 FT-LB) IN NUMBERED SEQUENCE SHOWN ABOVE.

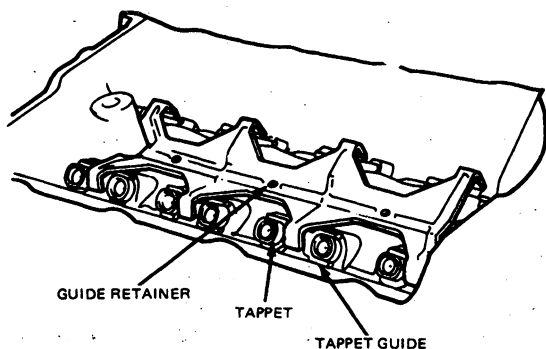
STEP 2. TIGHTEN BOLTS TO 33 N·m (24 FT-LB) IN LINE SEQUENCE SHOWN ABOVE.

A7814-1A

7. Remove bolts attaching valley pan strap to front of engine block, and remove strap.
8. Remove valley pan drain plug and remove valley pan.
9. If tappets are being serviced, remove valve covers, rocker arms and push rods, as outlined in this section.

NOTE: Tappets should be kept in order so they can be installed in their original position. Inspect and test each tappet separately to prevent intermixing the internal parts.

10. Remove tappet guide retainer.



A7374-1A

Installation

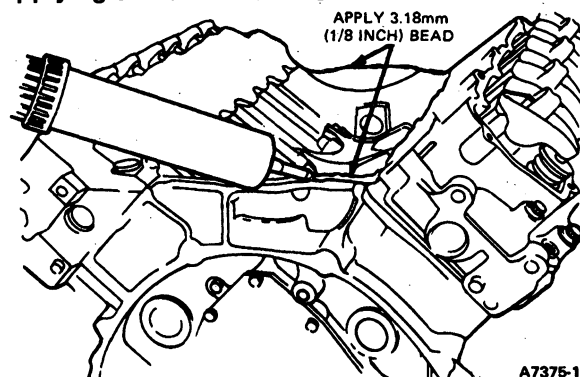
1. Lubricate tappets and bores with recommended quality engine oil and install tappets in their original positions.
2. Install tappet guides.
3. Install tappet guide retainer and tighten to specifications.
4. Position push rods, copper colored ends toward rocker arms, into their respective tappets making sure they are seated fully in push rod seats.

5. Install rocker arms and valve covers with new gaskets, as outlined.

NOTE: When applying Silicone Rubber Sealant always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to set-up and sealing effectiveness may be reduced.

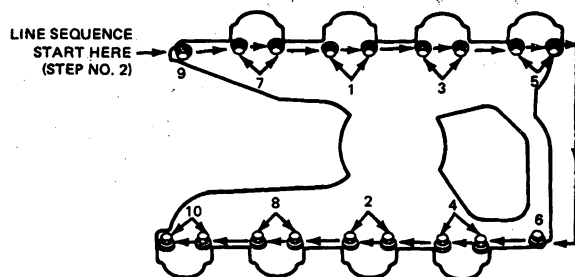
6. Clean cylinder block gasket surfaces of any old Silicone Rubber Sealant or oil. Apply a 3.18mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent to each end of the cylinder block.

Applying Silicone Rubber Sealant



A7375-1A

7. Install new valley pan.
8. Install valley pan drain plug.
9. Install valley pan strap onto front of valley pan and tighten to specification in Standard Torque Chart.
10. Install intake manifold and tighten to 33 N·m (24 ft-lb), using the two-step method shown.



STEP 1. TIGHTEN BOLTS TO 33 N·m (24 FT-LB) IN NUMBERED SEQUENCE SHOWN ABOVE.

STEP 2. TIGHTEN BOLTS TO 33 N·m (24 FT-LB) IN LINE SEQUENCE SHOWN ABOVE.

A7814-1A

NOTE: Connect engine wiring harness ground wire to rear of right cylinder head and tighten to specification.

11. Install engine wiring harness on engine.
12. Install injection pump, as outlined.
13. Connect No. 5 and No. 6 nozzle fuel return hoses.
14. Install turbocharger assembly, refer to Section 03-12B in this Supplement.
15. Install air cleaner assembly.

REMOVAL AND INSTALLATION (Continued)

16. Connect ground cables to both batteries.

WARNING: KEEP EYES AND HANDS AWAY FROM FUEL SPRAY. FUEL SPRAYING FROM PARTIALLY OPENED CONNECTION UNDER HIGH PRESSURE OPENED CONNECTION UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.

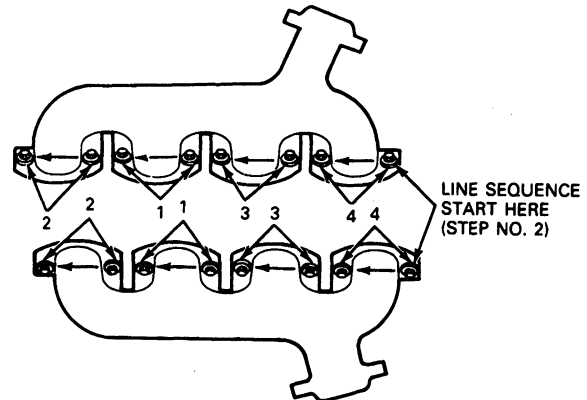
17. Run engine. Check for oil and fuel leaks.
18. If necessary, purge nozzle high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from the connection.

Exhaust Manifolds**Removal**

1. Disconnect ground cables from both batteries.
2. Raise vehicle.
3. Disconnect exhaust crossover pipe and Y-collector pipe from exhaust manifolds and turbocharger.
4. If right exhaust manifold is to be removed, lower vehicle at this time. If left exhaust manifold is to be removed, leave hoist up.
5. Remove exhaust manifold attaching bolts and manifold.

Installation

1. Clean mounting surfaces.
2. Apply anti-seize compound on exhaust manifold bolt threads and install left manifold with new gasket.
3. Tighten bolts to 47 N·m (35 ft-lb) using the two-step method shown. Raise vehicle.
4. If right exhaust manifold is being installed, raise vehicle at this time, and repeat installation Steps 2 and 3.

Exhaust Manifold Tightening Sequence

STEP1. TIGHTEN BOLTS TO 47 N·m (35 FT-LB), IN NUMBERED SEQUENCE SHOWN ABOVE.

STEP2. TIGHTEN BOLTS TO 47 N·m (35 FT-LB), IN LINE SEQUENCE SHOWN ABOVE.

A7912-1B

5. Connect exhaust crossover pipe and Y-collector pipe to manifolds and turbocharger assembly. Loosely install exhaust crossover pipe to left manifold. Install Y-collector pipe by tapping collector into turbocharger exhaust inlet with a long drift punch. Tighten nuts to specification. Refer to Section 09-00 Exhaust Pipes, Mufflers and Converters in this Supplement.
6. Lower vehicle.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

7. Connect battery ground cables to both batteries.
8. Run engine and check for exhaust leaks.

Thermostat

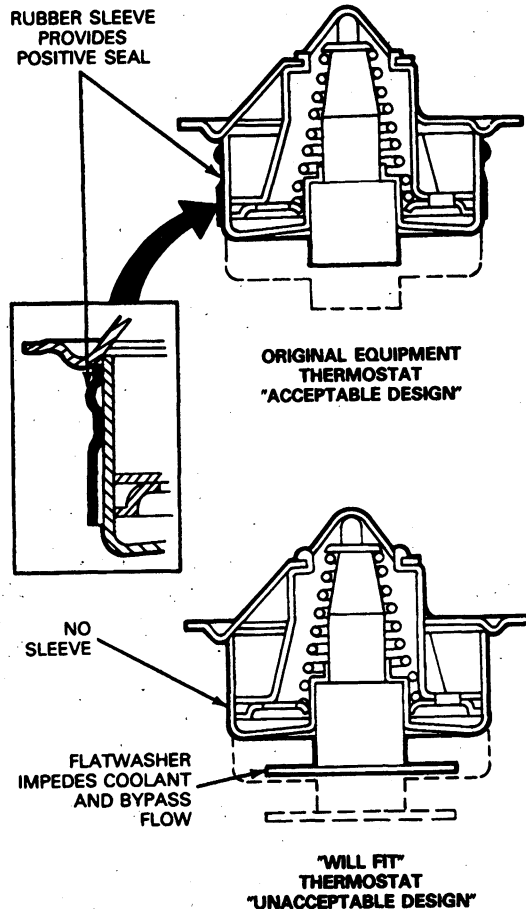
CAUTION: The specified thermostat does not contain an internal bypass, since the by-pass is located in the cylinder block. Whenever the thermostat is replaced, it is mandatory that only Motorcraft E5TZ-8575-C or Navistar 1807945-C1 thermostat be installed.

CAUTION: Do not attempt to repair the thermostat. It should be replaced if it is not operating properly.

Check the thermostat before installing it, following the procedure described under Cleaning and Inspection in this section.

REMOVAL AND INSTALLATION (Continued)

Thermostat Design (Acceptable vs. Unacceptable)



A11910-1A

Removal

1. Disconnect ground cables from both batteries.
2. Drain coolant from radiator until coolant level is below thermostat.
3. Remove accessory drive belt.
4. Remove alternator. Position alternator out of the way.
5. Remove the water outlet housing attaching bolts. Bend the radiator upper hose upward and remove the thermostat and gasket.
6. Inspect thermostat as outlined in this section.

Installation

1. Clean the water outlet housing gasket surfaces. Coat a new outlet housing gasket with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent.
 - Position the water outlet housing gasket on crankcase opening.

2. Install thermostat in crankcase opening with the copper pellet or element toward engine and the thermostat flange positioned in the recess. If thermostat is improperly installed, it will cause a restricted flow of coolant.
3. Position the water outlet housing against the crankcase. Install and tighten the attaching bolts to 27 N·m (20 ft-lb).
4. Install alternator.
5. Install accessory drive belt.
6. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling, in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
7. Connect ground cables to both batteries.

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN REVVING ENGINE.
8. Operate the engine until normal operating temperature is reached, then check the coolant level. Inspect cooling system for leaks.

Cylinder Heads

NOTE: Right side described; left side similar. Refer to Section 03-05, Accessory Drive in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual for differences in accessory drive for left side of engine.

TOOLS REQUIRED

Description	Tool Number
Fan Clutch Pulley Holder	T83T-6312-A
Fan Clutch Nut Wrench	T83T-6312-B
Fuel System Protector Cap Set	T83T-9395-A
Engine Lifting Brackets	T70P-6000

Removal

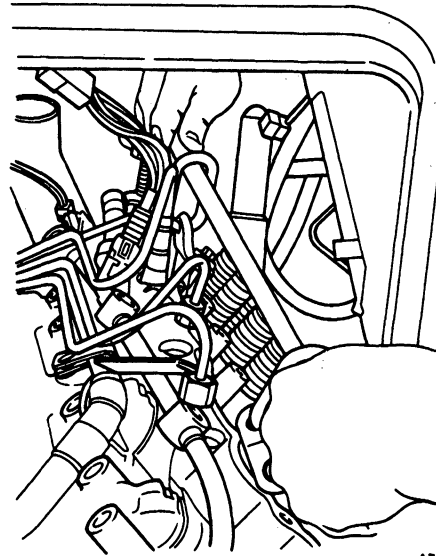
1. Disconnect ground cables from both batteries.
2. Drain cooling system.
3. Remove radiator fan shroud. Refer to Section 03-03, Engine Cooling, in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
4. Remove turbocharger assembly, refer to Section 03-12B, Turbocharger, 7.3L IDI Turbo Diesel V8 Engine in this Supplement.

CAUTION: Left-hand thread. Remove by turning nut clockwise.
5. Remove radiator fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.

REMOVAL AND INSTALLATION (Continued)

6. Disconnect alternator wiring from alternator. Disconnect wiring harness electric connector from top of fuel filter / fuel heater / water separator.
7. Remove fuel filter inlet, outlet and return lines. Cap lines and fittings with Fuel System Protector Cap Set T83T-9395-A.
8. Remove alternator and vacuum pump mounting brackets. Refer to Section 03-05, Accessory Drive, in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual. Remove fuel filter bracket with filter attached (right side only).
9. Remove heater hose from cylinder head.
10. Remove injection pump, as outlined.
11. Remove intake manifold and valley cover, as outlined.
12. Raise vehicle.
13. Disconnect exhaust crossover and Y-pipe from exhaust manifolds.
14. Remove bolt attaching transmission oil dipstick tube to cylinder head (right side only).
15. Lower vehicle.
16. Remove engine oil dipstick tube-fasteners (right side only).
17. Remove right-hand exhaust manifold, as outlined.
18. Remove engine oil dipstick, dipstick tube and O-ring (right side only).
19. Remove valve cover, rocker arms and push rods, as outlined.
20. Remove nozzles and glow plugs, as outlined.
21. Remove bolts attaching cylinder head to engine block.
22. Attach Engine Lifting Brackets T70P-6000 to each end of cylinder head.
23. Install lifting sling to lifting eyes and carefully lift cylinder head out of engine compartment.

CAUTION: Pre-combustion chamber inserts may fall out of cylinder head upon removal.



A7916-1A

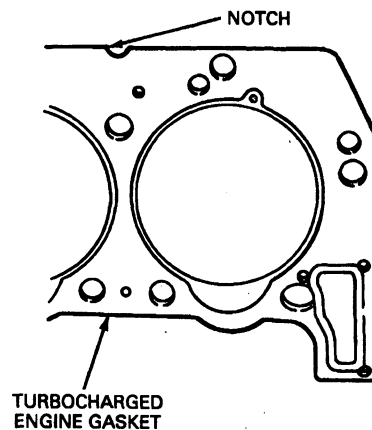
24. Remove head gasket carefully to prevent damage to cylinder head locating dowel sleeves.

Installation

NOTE: New cylinder head assemblies are interchangeable from one cylinder bank to another. Used cylinder heads should be installed into their original positions using new gaskets. Cylinder head gaskets are interchangeable.

1. Clean gasket surface. Remove all burrs or scratches with an oil stone.
- NOTE:** Cylinder heads are not to be resurfaced.
2. Check for warpage or cracks. Replace head if warped or cracked.

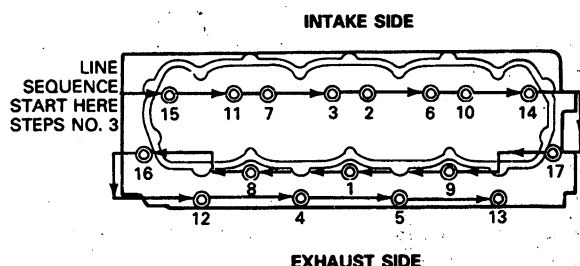
CAUTION: IDI turbo cylinder head gaskets are different than the naturally-aspirated diesel engine. They can be identified by a notch on the edge of the exhaust manifold side of the gasket.



A20415-A

REMOVAL AND INSTALLATION (Continued)

3. Position new cylinder head gasket on engine block using locating dowels. Install gasket with silver stamped "This Side Up" facing installer.
CAUTION: Use care when installing cylinder head to prevent prechambers from falling into cylinder bores. Do not slide cylinder head across gasket. Sliding head may damage seals and result in coolant or oil leakage.
4. On F-Series, attach lifting sling and brackets to cylinder head. Carefully lower cylinder head onto engine block.
CAUTION: Do not use anti-seize compounds, grease or any other lubricant except engine oil. Other lubricants have an adverse effect on torque value.
5. Lightly lubricate cylinder head bolt threads and mating surfaces of bolt heads with engine oil.
6. Install cylinder head retaining bolts. Tighten to specifications as shown.



- STEP 1. TIGHTEN BOLTS TO 88 N·m (65 FT-LB) IN NUMBERED SEQUENCE SHOWN ABOVE.**
STEP 2. TIGHTEN BOLTS TO 115 N·m (85 FT-LB) IN NUMBERED SEQUENCE SHOWN ABOVE.
STEP 3. TIGHTEN BOLTS TO 136 N·m (100 FT-LB) IN LINE SEQUENCE SHOWN ABOVE.
STEP 4. REPEAT STEP NO. 3.

A7913-1C

7. Install push rods, copper colored ends toward rocker arms, making sure push rods are fully seated into tappets.
8. Install valve rocker arms and posts in their original positions. Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to valve stem tips.
9. Install valve rocker arm post attaching bolts as follows:
 - a. Turn engine over by hand until timing mark is at 11:00 o'clock position as viewed from front of engine.
 - b. Install all rocker arm post attaching bolts, and tighten to 27 N·m (20 ft-lb).
10. Clean valve covers with clean solvent and install new gaskets.
11. Install valve covers on cylinder heads. Tighten attaching screws to 8 N·m (6 ft-lb).
12. Install valley pan and intake manifold, as outlined in this section.

13. Install injection pump, as outlined in this section.
 14. Connect heater hose to cylinder head and tighten clamp to specification. Refer to Section 03-03, Engine Cooling, in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
 15. Install fuel filter/fuel heater/water separator with bracket, and alternator and vacuum pump brackets and tighten to specification. Refer to Section 03-05, Accessory Drive, in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
 16. Remove protective caps and install fuel filter inlet, outlet and return lines. Tighten to specifications.
 17. Loosely install engine oil dipstick tube and O-ring into cylinder block (right side only).
 18. Raise vehicle.
 19. Install right exhaust manifold, as outlined. Install fasteners holding engine oil dipstick tube in position.
 20. Install bolt attaching transmission oil dipstick to cylinder block and tighten to specification (right side only).
 21. Connect exhaust crossover pipe and Y-pipe to exhaust manifolds and tighten to specification. Refer to Section 09-00 Exhaust Pipe, Mufflers and Converters in this Supplement.
 22. Lower vehicle.
 23. Install accessory drive belt.
 24. Connect alternator wiring harness. Connect wiring harness top of fuel filter/fuel heater/water expansion.
 25. Install turbocharger assembly. Refer to Section 03-12B in this Supplement.
 26. Install air cleaner assembly.
 27. Connect ground cables to both batteries.
 28. Refill and bleed cooling system. Refer to Section 03-03, Engine Cooling, in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
- WARNING: KEEP EYES AND HANDS AWAY FROM FUEL SPRAY. FUEL SPRAYING FROM THE PARTIALLY OPENED CONNECTOR UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.**
29. Run engine and check for fuel, coolant and exhaust leaks.
 30. If necessary, purge high-pressure fuel lines of air by loosening connector one half to one turn and cranking engine until bubble-free fuel flows from connection.

CAUTION: Left-hand thread. Tighten by turning nut counterclockwise.

REMOVAL AND INSTALLATION (Continued)

31. Install radiator fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.
32. Install radiator fan shroud.

Engine Oil Filter

Removal

1. Raise vehicle.
2. Remove oil filter, using a suitable oil filter wrench.

Installation

1. Clean gasket mating surface on oil filter flange.
2. Lightly coat sealing gasket with clean engine oil.
3. Install oil filter until seal contacts filter flange and tighten 1-1/4 to 2 additional turns.
4. Lower vehicle.
5. Check engine oil level, and add as required.
6. Run engine and check for oil leaks.

Engine Oil Cooler

TOOLS REQUIRED

Description	Tool Number
Fan Clutch Pulley Holder	T83T-6312-A
Fan Clutch Nut Wrench	T83T-6312-B

CAUTION: Do not start the engine after a debris-generated failure without replacing the oil cooler bundle. Debris cannot be filtered before entering the oil cooler since the filter is downstream of the cooler.

NOTE: If necessary, refer to Oil Cooler Internal Leakage Test and perform as outlined in this section.

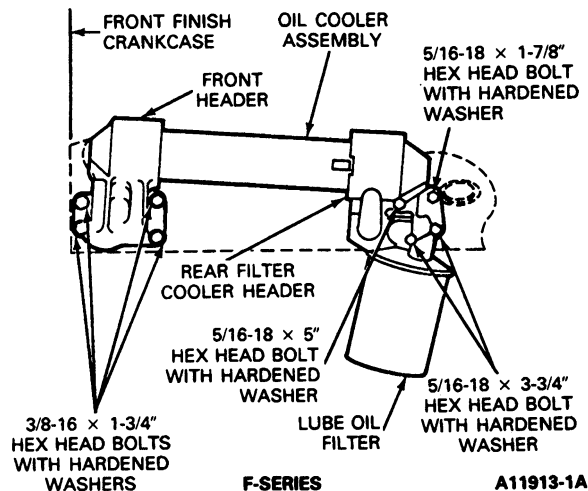
NOTE: When replacing a turbo diesel engine oil cooler be sure to use the correct replacement. The turbo engine oil cooler provides the necessary increased efficiency.

Removal

1. Disconnect ground cables from both batteries.
 2. Drain cooling system.
 3. Remove radiator fan shroud.
- CAUTION:** Left-hand thread. Remove by turning nut clockwise.
4. Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.
 5. Remove turbocharger assembly. Refer to Section 03-12B.
 6. Raise vehicle.
 7. Drain engine oil and remove oil filter. Do not install drain plug.

8. Remove nut attaching left engine mount insulator to frame. Slightly raise left side of the engine and install a 25mm (one inch) wood block between insulator and frame. Lower engine on block.
9. Remove bolts attaching oil cooler to engine block and remove engine oil cooler.

Oil Cooler Installation

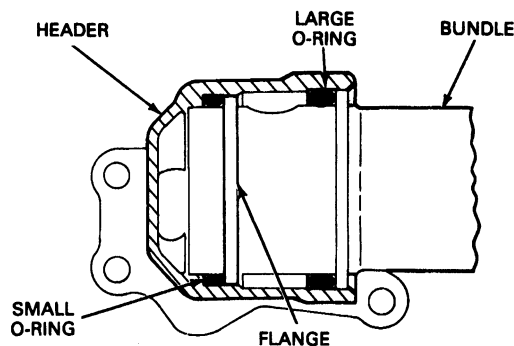


Installation

CAUTION: The inner O-ring must be installed on the cooler bundle to avoid cutting the inner O-ring during assembly.

NOTE: Four O-rings are used on the oil cooler.

1. Assemble cooler and headers; refer to Disassembly and Assembly. Install engine oil cooler assembly with new gaskets. Refer to Specifications, Standard Torque chart, at the end of this section.



NOTE: INSTALL THE LARGE O-RING ON THE OIL COOLER BUNDLE FIRST, THEN INSTALL THE SMALL O-RING ON THE COOLER BUNDLE.

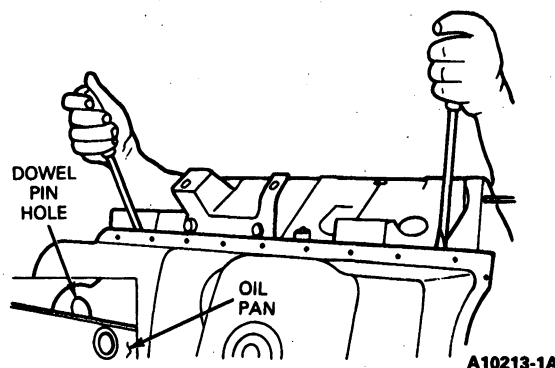
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2. Raise engine, remove wood block and lower engine onto No. 1 crossmember.
3. Install insulator attaching washer and nut. Tighten to specification.

REMOVAL AND INSTALLATION (Continued)

4. Lubricate oil filter gasket and install new oil filter until seal contacts filter flange. Tighten filter 1-1/4 to 2 additional turns. Install drain plug and tighten to specification.
5. Prime the entire engine lubricating system to fill the oil cooler, oil filter and cylinder block galleries with the specified type and grade of oil.
NOTE: Priming the lubricating system will minimize the possibility of scuffing or heat build-up during initial engine operation, which could lead to immediate or low mileage failure.
6. Lower vehicle.
7. Install turbocharger assembly. Refer to Section 03-12B in this Supplement.
8. Check the engine oil level and fill as necessary with the specified type and grade of oil.
9. Fill and bleed the cooling system. Refer to Section 03-03, Engine Cooling, in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
CAUTION: Left-hand thread. Turn nut counterclockwise to tighten.
10. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.
Tighten nut to 54-163 N-m (40-120 ft-lb).
11. Install radiator fan shroud.
12. Connect ground cables at both batteries.
13. Run engine and check for oil and coolant leaks.

9. Disconnect power steering return hose from pump. Plug hose and pump to prevent contamination of the system.
10. Disconnect alternator and air conditioner compressor wiring harness. Position the harness away from the engine.
11. Raise vehicle.
12. Disconnect and plug transmission oil cooler lines from radiator, if so equipped.
13. Disconnect and plug fuel pump inlet fuel hose.
14. Drain crankcase and remove oil filter.
15. Disconnect exhaust crossover and Y-collector pipe from exhaust manifolds and turbocharger.



16. Remove bolt attaching transmission oil filler tube to engine block and remove tube.
17. Remove nuts and washers attaching engine insulators to No. 1 crossmember.
18. Remove the two bolts securing the shift linkage bell crank to the transmission (automatic transmission). Let the linkage hang freely.
19. Lower vehicle.
20. Install lifting sling to lifting eyes on intake manifold and raise engine until transmission housing contacts body.
21. Install wood blocks (approximately 2-3/4 inches left side, 2 inches right side) between engine insulators and crossmember.
22. Lower engine onto blocks to support the engine.
23. Raise vehicle.
24. Remove flywheel inspection plate.
25. Position fuel pump inlet line at rear of No. 1 crossmember. Remove transmission oil cooler lines, if so equipped, and position out of way.
26. Remove oil pan retaining bolts and oil pan.
27. Remove oil pump and pickup tube.

Installation

1. Remove old gasket material. Clean mating surfaces of oil pan, engine block and front and rear covers with a suitable solvent and dry thoroughly.

Oil Pan, Oil Pump and Oil Pick-Up Tube**TOOLS REQUIRED**

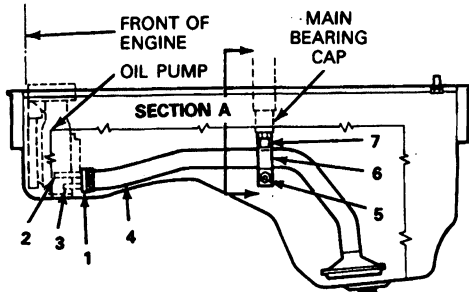
Description	Tool Number
Fan Clutch Pulley Holder	T83T-6312-A
Fan Clutch Nut Wrench	T83T-6312-B

Removal

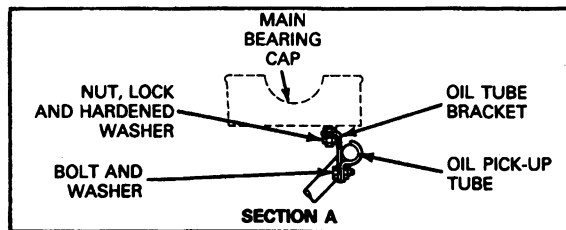
1. Disconnect ground cables from both batteries.
2. Remove engine oil level dipstick.
3. Remove air cleaner and intake tube.
CAUTION: Left-hand thread. Remove by turning nut counterclockwise.
4. Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B. Position the fan out of the way, in the fan shroud.
5. Remove turbocharger assembly. Refer to Section 03-12B Turbocharger, 7.3L IDI Turbo Diesel V8 Engine in this Supplement.
6. Install Intake Manifold Cover T83T-9424-A.
7. Drain cooling system.
8. Disconnect the upper lower radiator hoses.

REMOVAL AND INSTALLATION (Continued)

2. Clean mating surfaces of oil pickup tube. Inspect for cracks, and assemble to oil pump with new gasket, if removed. Refer to Specifications, Standard Torque chart.



1. OIL PICK-UP TUBE MOUNTING GASKET
2. 5/16"-18 x 2" BOLT AND 5/16" HARDENED WASHER
3. 5/16"-18 x 1-1/2" BOLT AND 5/16" HARDENED WASHER
4. OIL PICK-UP TUBE ASSEMBLY
5. 5/16"-18 x 0.930 BOLT W/WASHER
6. OIL TUBE BRACKET
7. 5/16"-18 NUT AND 5/16" LOCK AND HARDENED WASHERS



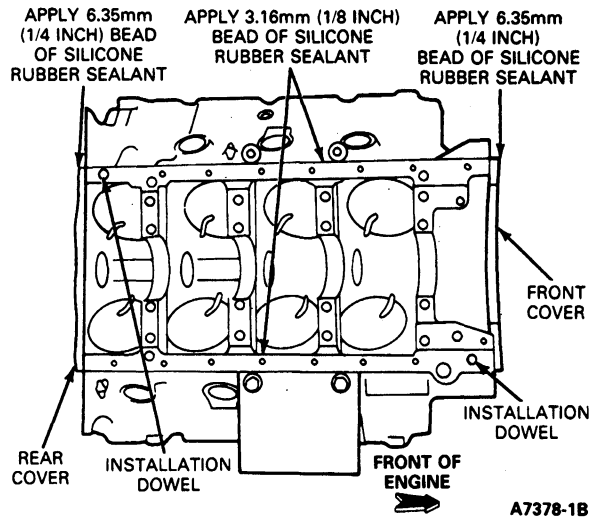
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NOTE: Prime oil pump with recommended engine oil. Rotate pump drive gear to distribute oil within pump body.

3. Install oil pump and tighten bolts to specification listed at the end of this section, if removed.

NOTE: When applying Silicone Rubber Sealant always use the bead size specified and join the components within 15 minutes of application. After 15 minutes, sealant begins to set-up and sealing effectiveness may be reduced.

4. Apply a 3.16mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent on side rails of engine block oil pan mating surface and on ends of engine oil pan mating surface on front and rear covers, and in mating corners.



5. Install locally fabricated oil pan installation dowels in position.
6. Position oil pan onto engine and install attaching bolts.
7. Remove oil pan locating dowels and install two remaining oil pan bolts. Tighten all oil pan retaining bolts. Refer to Specifications, Standard Torque chart at the end of this section.
8. Lower transmission and install the transmission mount retaining nuts. Tighten nuts to 96-128 N-m (70-94 ft-lb).
9. Install flywheel inspection plate and tighten to specifications.
10. Lower vehicle.
11. Raise engine and remove wooden engine support blocks.
12. Lower engine onto No. 1 crossmember and remove lifting sling.
13. Raise vehicle.
14. Position the automatic transmission filler tube (with a new O-ring) and install the retaining bolts. Tighten bolt to specifications. Refer to appropriate section in Group 07, Transmissions in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
15. Install nuts and washers attaching engine insulators to No. 1 crossmember and tighten to specifications.
16. On automatic transmission-equipped vehicles, position the shift linkage bell crank to the transmission and tighten the bolts to 27-40 N-m (20-30 ft-lb).

REMOVAL AND INSTALLATION (Continued)

17. Connect exhaust crossover pipe and Y-collector pipe to exhaust manifolds and tighten to specification. Start by installing crossover pipe loosely to left exhaust manifold. Install Y-collector pipe into turbocharger exhaust inlet by tapping on collector flange with a long drift punch until it is seated. Tighten nuts to appropriate specifications. Refer to Section 09-00 Exhaust Pipes, Mufflers and Converters in this Supplement.
18. Install oil pan drain plug and new oil filter. Tighten plug to 37 N·m (27 ft-lb).
19. Connect fuel pump inlet line to fuel pump and tighten to specification.
 - Make sure fuel line clip is installed in No. 1 crossmember.
20. Connect transmission oil cooler lines, if so equipped, and tighten to specification. Refer to appropriate section in Group 07, Transmissions in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
21. Lower vehicle.
22. Connect alternator and air conditioner compressor wiring harness to alternator and compressor. Connect wiring harness to top of fuel filter/fuel heater/water separator.
23. Connect power steering return hose to power steering pump.
24. Connect upper and lower radiator hoses and tighten clamps to 2-3 N·m (18-27 in-lb) double wire clamp; 3-4 N·m (27-35 in-lb) screw clamp.
CAUTION: Left-hand thread. Install by turning nut counterclockwise.
25. Install radiator fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B and tighten to 54-163 N·m (40-120 ft-lb).
26. Remove intake manifold cover.
27. Install turbocharger assembly. Refer to Section 03-12B, Turbocharger, 7.3L IDI Turbo Diesel V8 Engine in this Supplement.
28. Install air cleaner and intake tube. Refer to Section 03-12, Air Intake, in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
29. Install engine oil and transmission oil dipsticks.
30. Refill and bleed cooling system. Refer to Section 03-03, Engine Cooling, in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
31. Fill crankcase with specified quantity and viscosity of engine oil.
32. Connect ground cables to both batteries.
33. Run engine and check for oil, fuel and coolant leaks.

34. Check power steering fluid and add, if necessary.

Pistons and Connecting Rods

CAUTION: Do not use a power wrench for removing or installing connecting rod bolts, nuts and washers. Power wrench usage will cause seizure of connecting rod bolt or nut threads.

Removal

1. Remove engine from vehicle and place on an engine stand as outlined in this section, remove injection pump, intake manifold, cylinder heads, oil pan, and oil pump as outlined.
2. Remove any ridges and/or deposits from upper end of cylinder bores as follows:
 - a. Turn crankshaft until piston to be removed is at the bottom of its travel. Place a cloth on piston head to collect cuttings. Remove any ridge and/or deposits from upper end of cylinder bores.
 - b. Remove cylinder ridge with a razor knife or equivalent. Carefully scrape ridge away.
3. Mark all connecting rods and caps to permit installation into original positions. **Be sure to install pistons in same cylinders from which they were removed, or to which they were fitted. Connecting rods and bearing caps must be numbered 1, 3, 5, 7, in left bank, beginning at front of engine. The numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with a new cylinder number.**
4. Turn crankshaft until connecting rod being removed is down before dead center (BDC).
5. Remove connecting rod nuts and cap.
6. Install Connecting Rod Installation Guides D83T-6136-A or equivalent onto connecting rod bolts.
7. Push connecting rod and piston assembly out top of cylinder with handle end of a hammer. **Avoid damage to cooling jets, crankshaft journal or cylinder wall when removing piston and rod.**
8. Remove bearing inserts from connecting rod and cap, if required.
9. Install cap onto connecting rod from which it was removed.

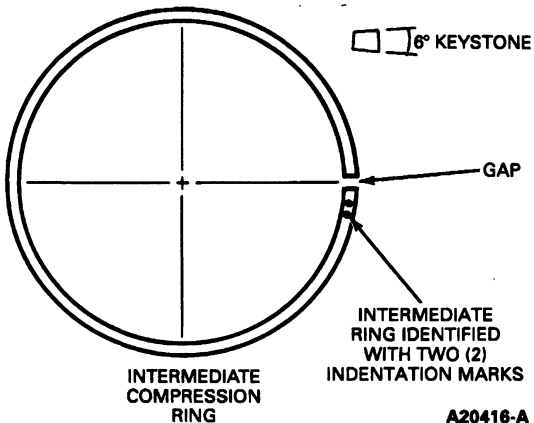
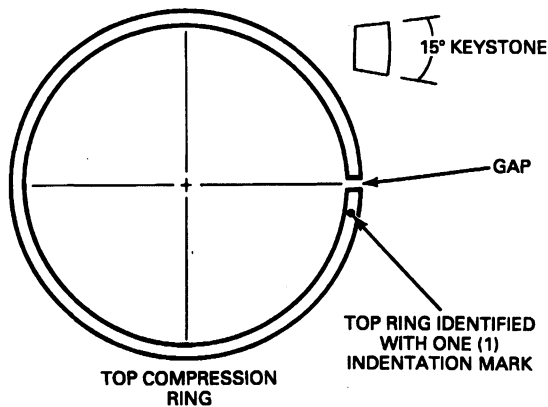
Installation

1. Remove cylinder wall glaze if new piston rings are to be installed. Follow instructions of the tool manufacturer. Cylinder bores must be cleaned with a soap and water solution after deglazing or honing. Dry and oil cylinder walls immediately after cleaning as outlined. Use proper size ring installer tool.

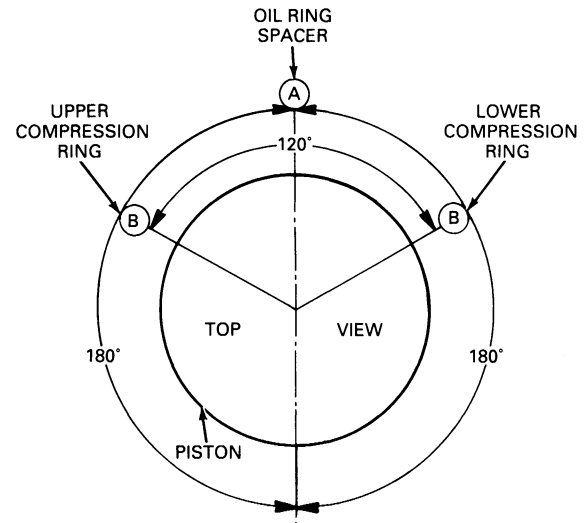
REMOVAL AND INSTALLATION (Continued)

2. Oil piston rings, pistons, and cylinder walls with specified engine oil. **Be sure to install pistons in same cylinders from which they were removed, or to which they were fitted. Connecting rods and bearing caps must be numbered 1, 3, 5, 7, in left bank, beginning at front of engine. The numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with a new cylinder number.**
3. Make sure ring gaps (oil ring spacer-A, compression rings-B) are properly spaced around circumference of piston. Piston rings are identified by indents as shown.

Ring Identification

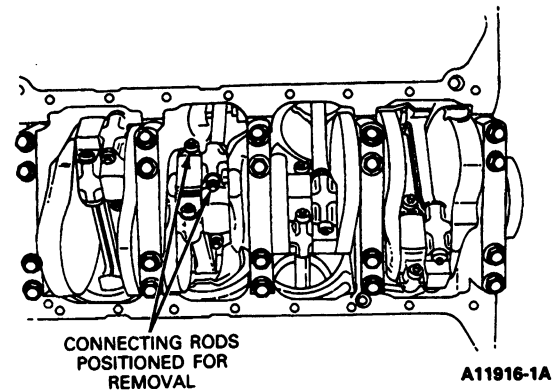


Piston Ring Spacing



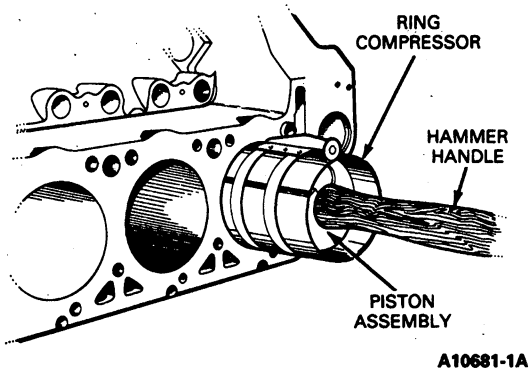
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4. Turn crankshaft throw to position shown.



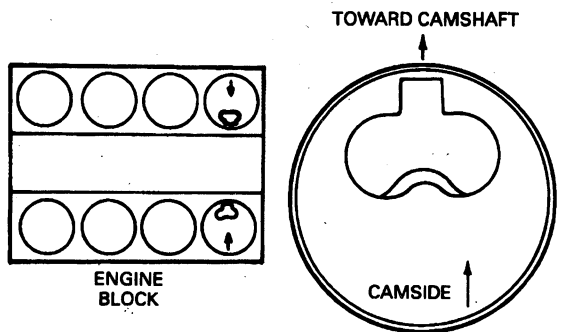
REMOVAL AND INSTALLATION (Continued)

5. Install connecting rod upper bearing. Install Connecting Rod Installation Guides D83T-6136-A or equivalent. Before installing, make sure that large chamfer on connecting rod faces crankshaft check (facing toward front on engine on right bank rods, and toward rear of engine on left bank rods). Install Piston Ring Compressor D81L-6002-C or equivalent onto piston and push piston in with a hammer handle until it is slightly below top of cylinder. Guide connecting rods to avoid damaging cooling jets and crankshaft journals. **Install piston with arrow and eyebrows on piston head toward camshaft.**



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Piston Orientation



A7379-D

6. Push piston downward until connecting rod bearing seats on crankshaft journal. Remove protective sleeves and install lower bearing and cap.
7. Check clearance of each bearing and connecting rod side clearance following procedure described under Main and Connecting Rod Bearings.
8. Apply a light coat of specified engine oil to journals and bearings.
NOTE: Lightly coat bolt threads with oil before installing.
9. Install connecting rod cap and bearing. Tighten connecting rod nuts alternately to 52 N·m (38 ft-lb). Tighten nuts to 69 N·m (51 ft-lb).

Crankshaft

TOOLS REQUIRED

Description	Tool Number
Engine Lifting Brackets	T70P-6000

Removal

1. With engine removed from vehicle and placed on an engine stand, as outlined in this section, remove injection pump and adapter, engine front and rear covers, oil pan, oil pump and pick up, as outlined.
2. Mark all bearing caps (main and connecting rod) to permit installation into their original locations.
CAUTION: Use care to avoid damage to crankshaft journal, cooling jets and cylinder wall when moving piston assembly.
3. Turn crankshaft until connecting rod from which cap is being removed is down bottom dead center (BDC) and remove bearing cap. Install Connecting Rod Installation Guides D83T-6136-A or equivalent and push connecting rod and piston assembly up into cylinder. Remove rod and piston from cylinder. Remove guides and install bearing cap. Repeat this procedure until all connecting rods are removed.
4. Remove main bearing caps. Main bearing caps are numbered from front of engine.
5. Install Engine Lifting Brackets T70P-6000 to crankshaft and lift crankshaft out of block so that thrust bearing surfaces are not damaged. **Handle crankshaft with care to avoid possible fracture or damage to finished surfaces.**

Crankshaft Repair

Clean all parts with cleaning solvent, dry with compressed air, and inspect bearings for wear and evidence of uneven bearing support. If such evidence is present, examine bearing caps and supporting surfaces or crankcase for high spots and burrs.

Inspect crankshaft journals for scoring, burning and cracking. Measure diameter of each journal using a micrometer. Check dimensions obtained against specifications listed at the end of this section. Measure each journal at two points, one at right angles to other, in order to show any evidence of out-of-round. Move micrometer over entire width of journal.

Crankshafts must not be straightened. Even slight straightening with complete absence of cracks will endanger the high strength built into the shaft.

Bearing failures can cause overheating of crankshaft journals and a reduction of hardness. When this occurs, the crankshaft strength may be unacceptably reduced. Whenever bluing is found on the journal or fillet area, the crankshaft must be replaced.

Crankshaft Grinding

An induction-hardened fillet and journal crankshaft can be reground for undersized bearings.

REMOVAL AND INSTALLATION (Continued)

Crankshafts should be ground at a qualified machine shop, experienced in grinding induction hardened crankshafts. Crankshafts should be magnifluxed after grinding to make sure that there are no surface cracks.

Grinding Limits

Maximum allowable taper on crankpins (rod journals) and main journals is .013mm (.0005 inch) per 25.4mm (1 inch) of length. Crankpins and journals must be polished from 508 Micro-mm (20 Micro-inch) maximum to 127 Micro-mm (5 Micro-inch) minimum, and must not be over 0.003mm (0.0001 inch) out of round.

The main journal fillet radii should be 3.07-3.226mm (.121-.127 inch) with the crankpins (rod journals) fillet radii held at 3.05mm (.120 inch).

The third main journal controls crankshaft end thrust and provides initial location of crankshaft in relation to crankcase. For this reason the width of the third journal must be 28.766-28.841mm (1.1325-1.1355 inches).

Fitting Main or Connecting Rod Bearings With Plastigage

TOOLS REQUIRED

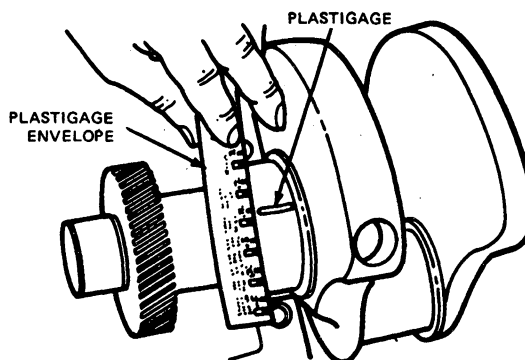
Description	Tool Number
Dial Indicator with Bracketry	TOOL-4201-C

Main Bearings

NOTE: Be sure bearing inserts, bearing bore and mating surfaces are clean. Foreign material under inserts will distort bearing and cause incorrect readings and subsequent bearing failure.

To obtain an accurate reading using plastigage method of checking, all bearing caps must be in place and tightened to 129 N·m (95 ft-lb), then turn bolts an additional 45°.

1. Remove one bearing cap and insert. Leave remaining caps tight while checking fit of bearing.
2. Wipe oil from all contact surfaces such as crankshaft journal, bearing insert, bearing caps, etc.
NOTE: Lightly coat bolt threads with oil before installing.
NOTE: Do not turn crankshaft while making check with plastigage.
3. Place piece of Plastigage D81L-6002-B or equivalent across full width of bearing surface on crankshaft journal (or bearing cap insert) approximately 6.35mm (1/4 inch) off center. Install bearing cap and tighten cap bolt to specification.
4. Remove bearing cap and insert.
5. Do not disturb plastigage. Using plastigage envelope, measure widest point of plastigage. Reading indicates bearing clearance in thousandths of an inch.



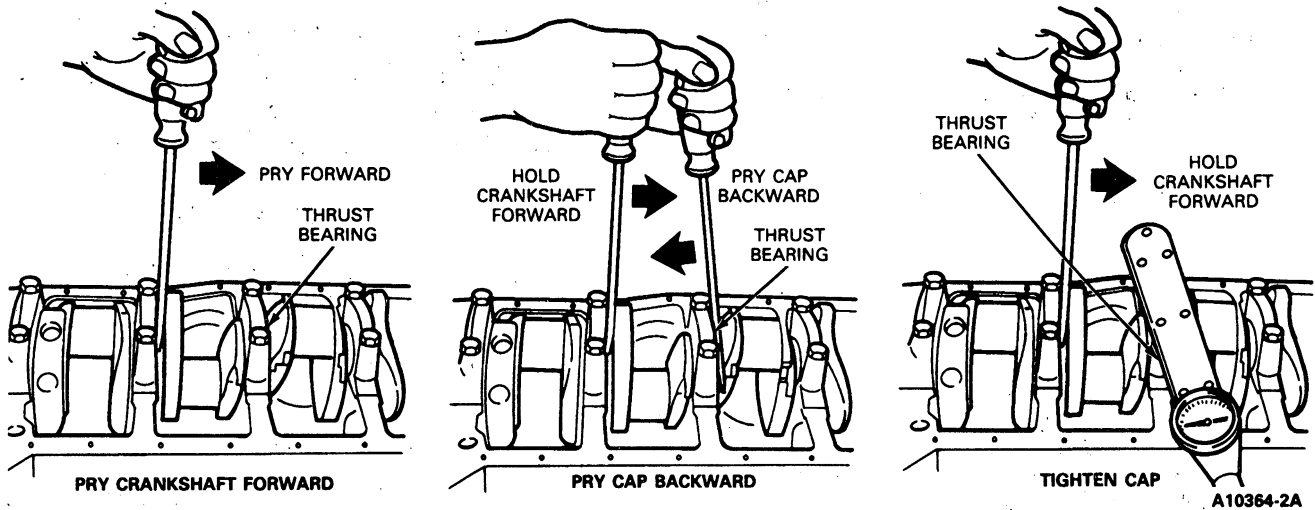
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6. Crankshaft must be reground and undersize bearings installed if the bearing clearance is not within specifications.
7. Use Dial Indicator with Bracketry TOOL-4201-C to check end play as outlined in Section 03-00, Engine Service, Gasoline in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.
8. Install correct undersize bearings if crankshaft main bearing journals have been refinished to a definite undersize. Make sure bearing inserts and bearing bores are clean. Foreign material under inserts will distort bearings and cause failure.
9. Place upper main bearing inserts with tangs fitting in slots, and oil holes into position in bores. Do not install thrust bearing (No. 3 main bearing) at this time.
10. Install lower main bearing inserts into bearing caps.
11. Carefully lower crankshaft into place. **Handle crankshaft with care to avoid possible fracture or damage to finished surfaces.** If necessary refer to Cleaning and Inspection.
12. Remove lifting eyes.
13. Install upper No. 3 main bearing (thrust flanges and oil hole) by rolling main bearing into saddle.
14. Check clearance of each main bearing following procedure under Fitting Main and Connecting Rod Bearings.
15. Apply specified engine oil to journals and bearings.
16. Install all bearing caps, except thrust bearing cap (No. 3 bearing). **Be sure that main bearing caps are installed in their original locations.** Tighten bearing cap bolts to 129 N·m (95 ft-lb), then turn bolts an additional 45°.
17. Install thrust bearing cap with bolts finger-tight.
18. Pry crankshaft forward against thrust surface of upper half of bearing.
19. Hold crankshaft forward and pry thrust bearing cap to rear. This will align thrust surfaces of both halves of bearing.
20. Retain forward pressure on crankshaft. Tighten cap bolts to specification.

REMOVAL AND INSTALLATION (Continued)

21. Force crankshaft toward rear of engine.

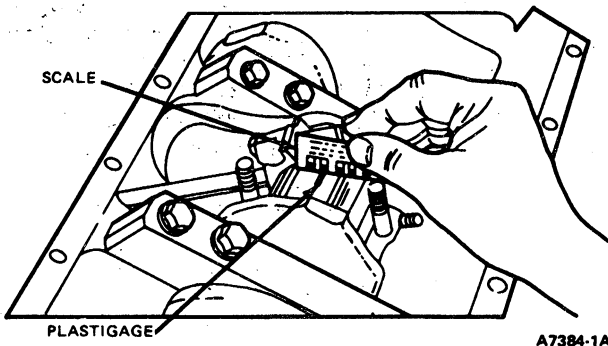
Aligning Thrust Bearing Cap, Typical



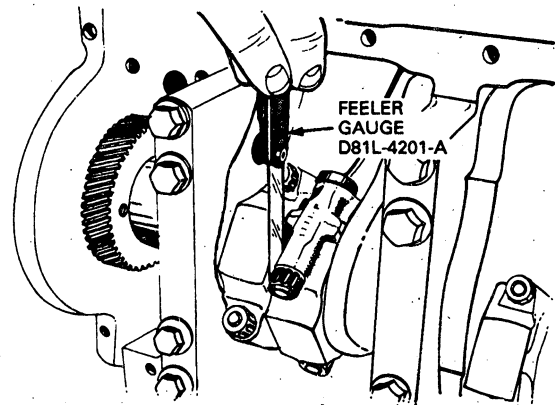
Connecting Rod Bearings

NOTE: Make sure bearing inserts, bearing bore and mating surfaces on connecting rod and cap are clean. Foreign material under inserts will distort bearing and cause incorrect readings and subsequent bearing failure.

1. Remove bearing cap and wipe oil from face of bearing insert and exposed portion of crankshaft journal.
2. Place a piece of Plastigage Tool D81L-6002-B or equivalent on bearing surface across full width of bearing about 6.35mm (1/4 inch) off center.
NOTE: Lightly coat bolt threads with oil before installing.
NOTE: Do not turn crankshaft while plastigage is in place.
3. Install cap and tighten nuts to 52 N-m (38 ft-lb) then retighten nuts to 69 N-m (51 ft-lb).
4. Remove bearing cap and use plastigage scale to measure widest point of plastigage. Reading indicates bearing clearance in thousandths of an inch. The opposite side of the scale indicates bearing clearance in tenths of millimeters.



5. Crankshaft must be reground and undersize bearings installed if bearing clearance is not within specifications.
6. Check connecting rod end clearance using Feeler Gauge D81L-4201-A or equivalent as shown. Excessive clearance may require replacement of rods or shaft. Check should be made to make certain specified running clearance exists. Lack of clearance could indicate damaged rod or rod bearing out of position.



Installation

1. Clean mating surfaces of block and main bearing caps.
2. Install correct size bearing inserts in connecting rod and cap. Make sure bearing inserts and bearing bores are clean. Foreign material under inserts will distort bearings and cause premature failure.

REMOVAL AND INSTALLATION (Continued)

3. Carefully install connecting rod and bearing onto crankshaft journal.
4. Install rod cap and bearing. Seat cap on connecting rod. Do not use cap nuts to pull cap onto connecting rod.
5. Install rod nuts and tighten to 52 N·m (38 ft·lb) then retighten nuts to 69 N·m (51 ft·lb).
6. Check rod bearing clearance again.
7. Check connecting rod side clearance. Refer to specifications at the end of this section.

Camshaft**TOOLS REQUIRED**

Description	Tool Number
Camshaft Bearing Set	T65L-6250-A
Crank / Cam Gear and Damper Replacer	T83T-6316-B

Removal

1. Remove engine from vehicle as outlined in this section.
2. With engine placed on an engine stand, remove injection pump and adapter, intake manifold and tappets, engine front cover and fuel supply pump as outlined in this section.

CAUTION: Use care to avoid damaging camshaft bearings.

3. Remove camshaft drive gear, fuel supply pump cam, spacer and thrust plate from the camshaft as outlined in this section.
4. Remove camshaft.

Camshaft Repair

Remove light scuffs, scores or nicks from camshaft machined surfaces with smooth oil stone marks.

Installation

Coat camshaft lobes with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent and lubricate journals with specified engine oil before installation.

1. Oil camshaft journals and apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to lobes. Carefully slide camshaft through bearings. If tools are available, a handle may be fabricated for easier installation of camshaft by connecting the Puller Screw Extension from Camshaft Bearing Set T65L-6250-A into suitable camshaft installation adapter. This assembly is then connected onto the end of the camshaft prior to installation. Remove the handle assembly when camshaft is properly seated in the bearings. Install new camshaft thrust plate onto cylinder block and tighten to specification listed at the end of this section.

2. Install spacer and fuel pump cam against camshaft thrust flange using Crank / Cam Gear and Damper Replacer T83T-6316-B.
3. Install camshaft drive gear against fuel pump cam, aligning timing mark with timing mark on crankshaft drive gear using Crank / Cam Gear and Damper Replacer T83T-6316-B.
4. Install camshaft Allen screw and tighten to 20 N·m (15 ft·lb).
5. Install fuel supply pump, as outlined in this section.
6. Install new crankshaft oil seal in engine front cover as outlined in this section.
7. Install engine front cover as outlined in this section.
8. Install water pump as outlined in this section.
9. Install injection pump adapter as outlined in this section.
10. Lubricate tappets and bores with specified engine oil and install tappets in their original positions.
11. Install tappet guides.
12. Install tappet guide retainer and tighten to specification listed at the end of this section.
13. Position push rods, copper colored ends toward rocker arms, into their respective tappets making sure they are seated fully in push rod seats.
14. Install rocker arms and valve covers with new gaskets as outlined.
15. Install intake manifold as outlined in this section.
16. Install injection pump as outlined in this section.
17. Install engine into vehicle as outlined in this section.

Camshaft Bearings

The bearings are interchangeable from one bore to another except for the front bearing which is wider than the others.

Removal

1. Remove engine from vehicle as outlined in this section. Mount engine stand using Rotunda Engine Stand Mounting Adapter 014-00306 or equivalent.

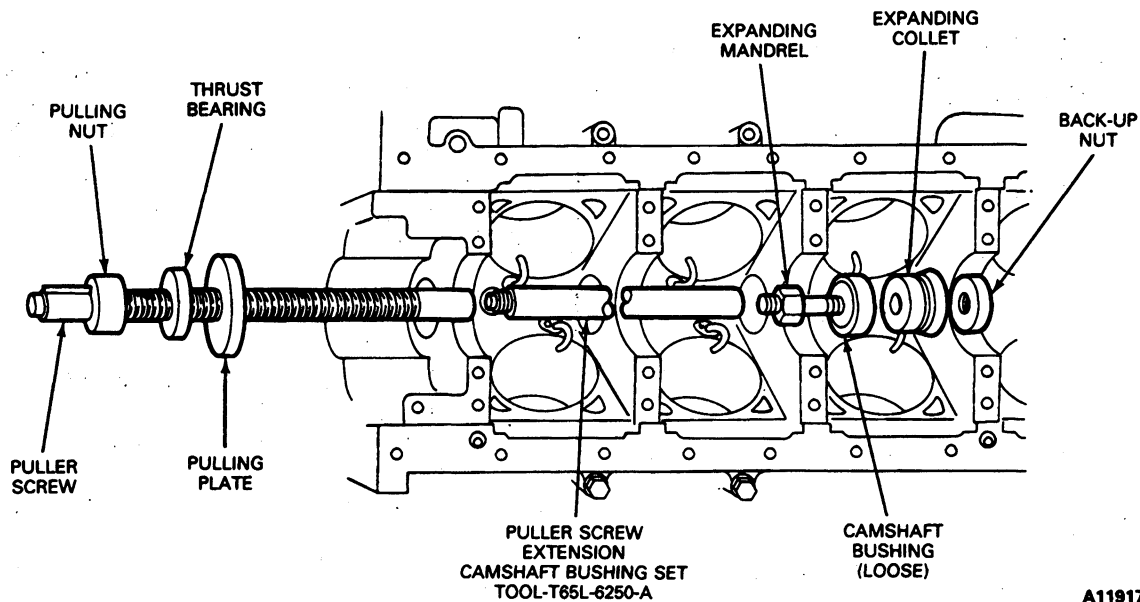
CAUTION: Use care when pushing pistons to top of cylinders to prevent damage to piston cooling jets. Using Connecting Rod Installation Guides D83T-6136-A or equivalent to protect connecting rod bolts.

2. Remove camshaft, flywheel and crankshaft, following appropriate procedures in this section. Push pistons to top of cylinders.

REMOVAL AND INSTALLATION (Continued)

- Using Camshaft Bearing Set T65L-6250-A select proper size expanding collet and backup nut and assemble on expanding mandrel. With expanding collet collapsed, install collet assembly in camshaft bearing, and tighten back-up nut on expanding mandrel until collet fits camshaft bearing.

Camshaft Bearing Replacement, Typical



A11917-2A

- Assemble puller screw and extension, if necessary, as shown and install on expanding mandrel. Wrap a cloth around threads of puller screw to protect front bearing or journal. Tighten pulling nut against thrust bearing and pulling plate to remove camshaft bearing. Be sure to hold wrench on end of puller screw to prevent it from turning.
- Repeat procedure for each bearing. To remove front bearing, install puller screw from rear of cylinder block.

Installation

- Position new bearings at bearing bores with oil holes aligned, and press in place with Camshaft Bearing Set T65L-6250-A shown under Removal. Be sure to center pulling plate and puller screw to avoid damage to bearing. **Failure to use correct expanding collet can cause severe bearing damage. Be sure front bearing is installed the specified distance below front face of cylinder block.**
- Install camshaft, crankshaft, flywheel and related parts, as outlined. It is not necessary to check connecting and main bearing clearances as a part of camshaft bearing replacement.

- Install engine into vehicle as outlined in this section.

Core Plugs

Removal

- Drill a 13mm (1/2 inch) hole in the center of core plug to be replaced.
- Remove core plug using a small pry bar.

Installation

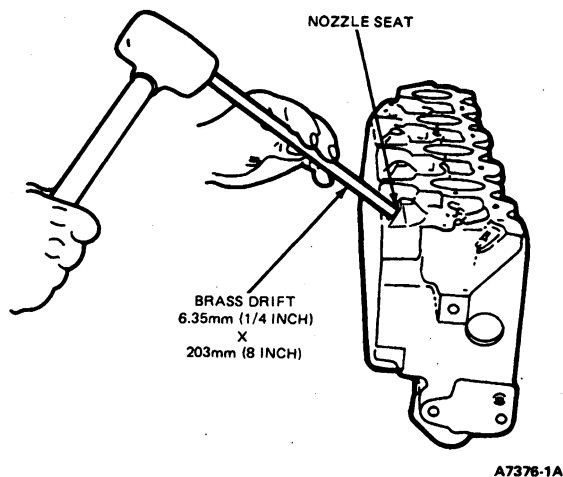
- Coat the core plug and /or bore lightly with an oil resistant Sealing Compound E0AZ-19554-B or EAZ-19544-B or equivalent.
- Install the new core plug with the concave side toward the engine.
- Install core plug using Expansion Plug Replacer D83T-6015-B or equivalent.

DISASSEMBLY AND ASSEMBLY

Cylinder Head Assembly

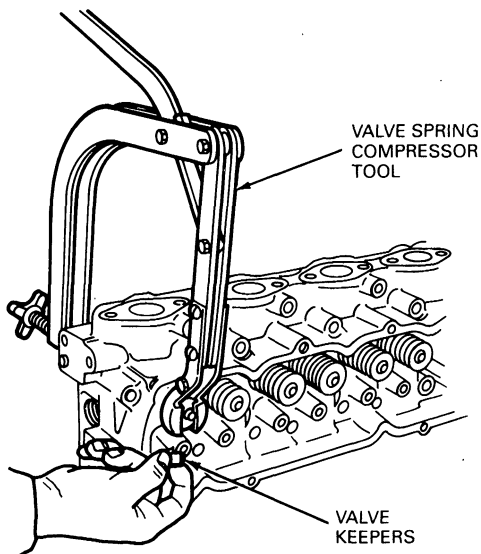
Disassembly

1. Remove precombustion chamber inserts using a 6.35mm x 203mm (1/4-inch x 8-inch) brass drift and suitable hammer.



NOTE: Be careful not to damage the cylinder head gasket surface.

2. Place cylinder head in suitable holding fixture.
NOTE: It may be necessary to strike valve stem end with a light, soft hammer to loosen valve keepers.
3. Install C-clamp type Valve Spring Compressor tool and compress valve spring and remove valve keeper.



NOTE: Keep valves and their related parts together so they may be installed in their original positions. Refer to Valve Spring, Retainer and Stem Seal in this section.

4. Release spring compressor and remove spring retainer, valve spring and damper assembly.

NOTE: Remove any burrs from valve stem before removing valves to prevent damage to the valve guide bore.

5. Remove valve seal, valve rotators and valves.

Valve Guides

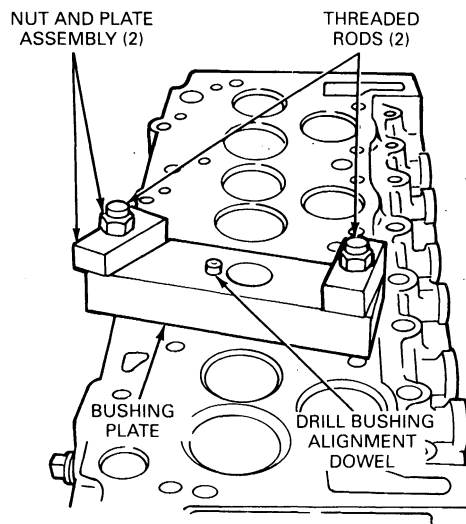
Removal and Installation

Excessive guide clearance prevents adequate cooling of valve through guide and allows valve to tilt or tip which may cause valve breakage at high engine speed. These conditions prevent good seating and promote leakage past valve face. If valve guides are either larger than specified or damaged, use suitable valve guide tools and follow manufacturer's instructions. Install as follows:

1. Remove cylinder head and valve as outlined in this section.

NOTE: Valve guides can be serviced using ZTSE-4157 Tool Kit which can be purchased from Owatanna Tool Company at OTC Division, SPX Corporation, 655 Eisenhower Drive, Owatanna, MN 55060 or call 1-800-533-5338.

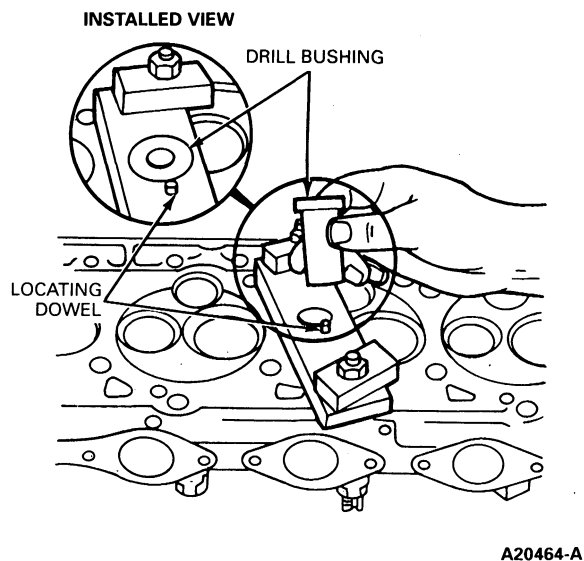
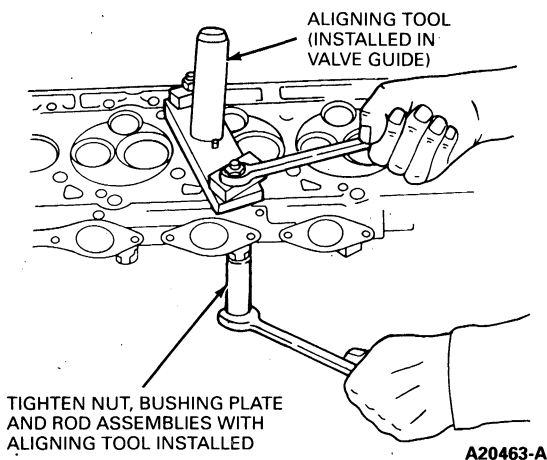
NOTE: Valve guides are cast into the cylinder head and must be drilled out to install service guides.



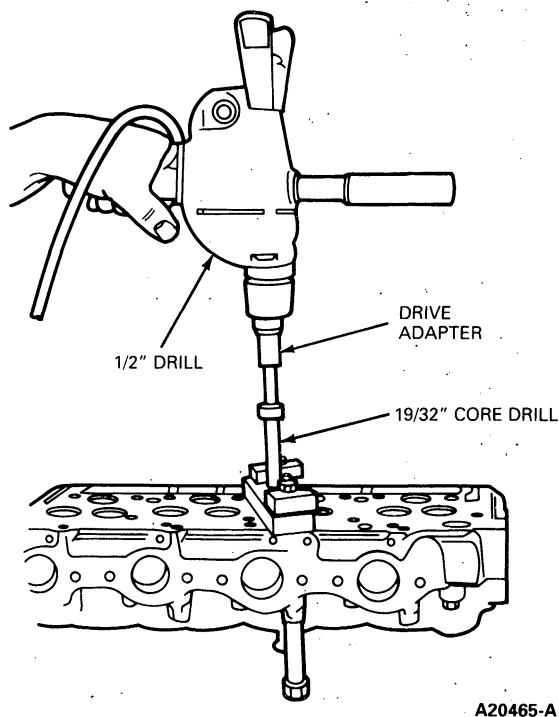
2. With cylinder head mounted in a holding fixture or on wood blocks, place the bushing plate over the guide to be serviced. Use the two threaded rods, the two nut and plate assemblies and the bushing plate. **DO NOT** tighten at this time.
3. Place the aligning tool through the hole in the bushing plate and into the valve guide in the cylinder head. The hole in the bushing plate is now concentric with the valve guide.

DISASSEMBLY AND ASSEMBLY (Continued)

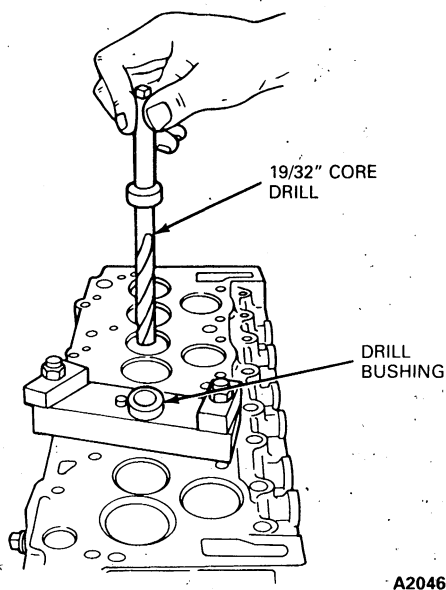
4. Tighten the nuts holding the bushing plate.



5. Remove the aligning tool and insert the 19/32 inch drill bushing.
- NOTE: Drill speed should not exceed 600 RPM.
6. Using a 1/2 inch electric drill with the drive adapter installed in the chuck, drill out the cast valve guide, lubricate with cutting oil during drilling.



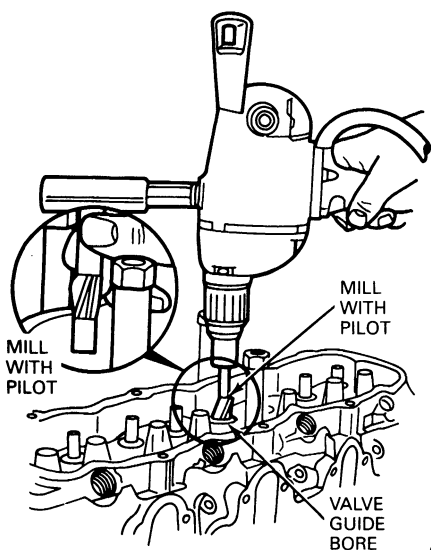
7. Insert the 19/32 inch core drill into the drill bushing. Deburr valve guide bore.



8. Remove the core drill and bushing.
9. Turn the cylinder head over to mill the remains of the cast guide on the top of the cylinder head.

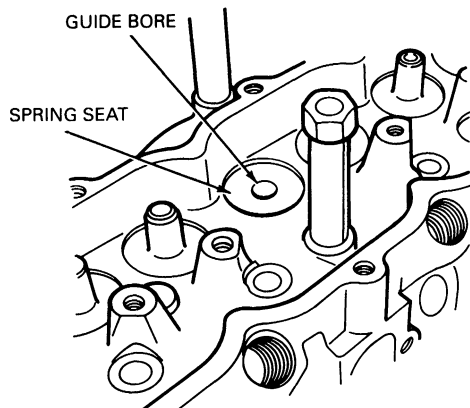
DISASSEMBLY AND ASSEMBLY (Continued)

10. Attach the pilot to the end mill.



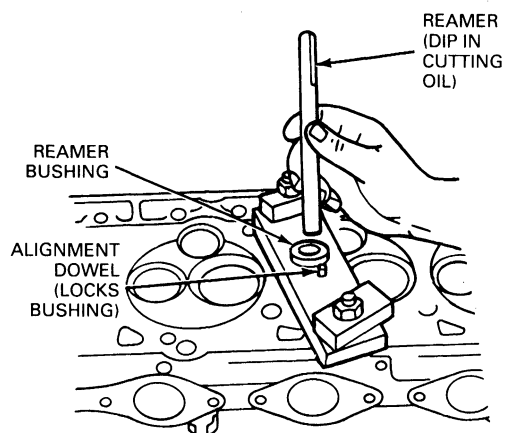
A20467-A

11. Mill until the guide bore is flush with spring seat.



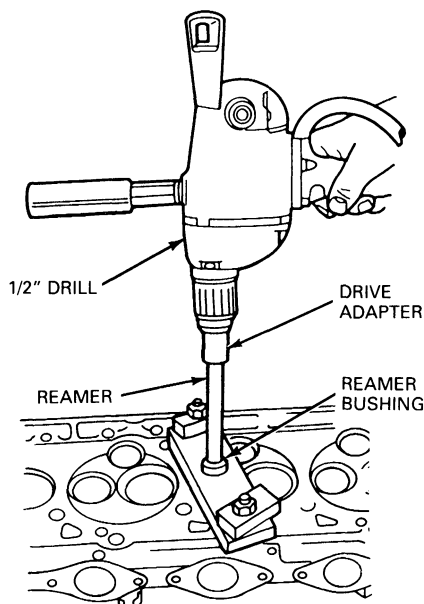
A20468-A

12. Turn the cylinder head over to the combustion chamber side.
13. Insert the reamer bushing into the bushing plate
NOTE: Refer to Specifications for valve guide insert bore diameter specification.
14. Dip the first three inches of the reamer in cutting oil and install it into the reamer bushing.



A20469-A

15. Attach the drive adapter to a 1/2 inch drill and ream through the cylinder head.
16. Remove the reamer and bushing.

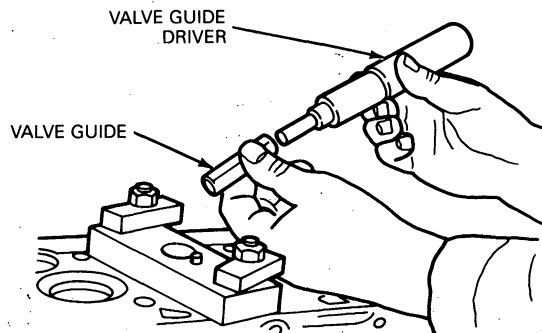


A20470-A

17. Position a new valve guide on the valve guide driver.

DISASSEMBLY AND ASSEMBLY (Continued)

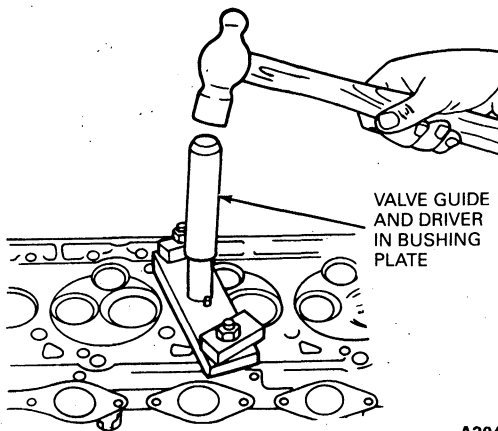
18. Lubricate the valve guides and bore with clean engine oil prior to assembly.



A20471-A

NOTE: Freezing the valve guide will assist in installation.

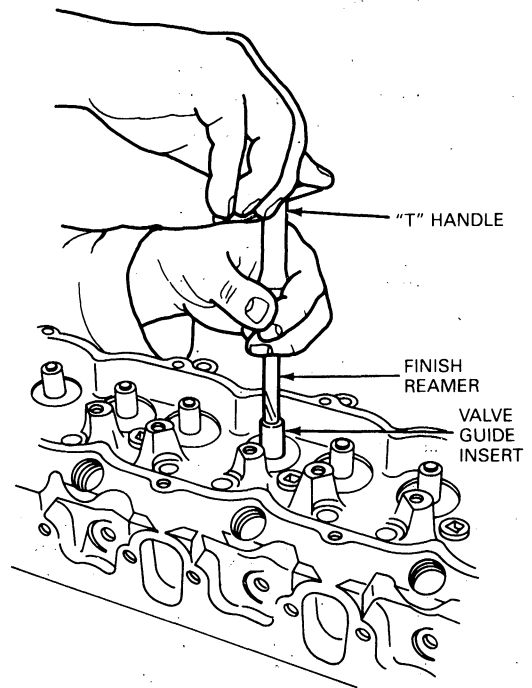
19. Insert the valve guide through the bushing plate and drive the guide into the head until the driver stops on the bushing plate.



A20472-A

NOTE: Refer to Specifications for valve guide bore diameter.

20. Remove the bushing plate and use the valve guide finishing reamer to finish the new valve guide insert bore.



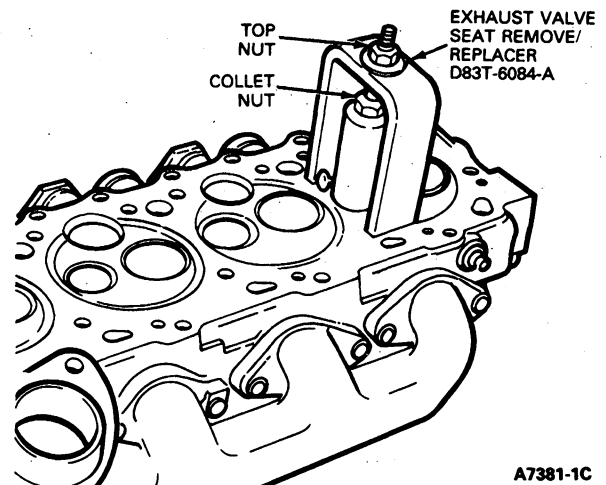
A20473-A

Valve Seats

Prior to seat reconditioning, clean seats and inspect for cracks, burning or other damage. Inspect exhaust seat inserts for looseness.

Exhaust Seats, Removal

1. Use Exhaust Valve Seat Remover / Replacer D83T-6084-A or equivalent to remove damaged or loose seats. Position removal collet into insert and rotate collet nut clockwise to expand collet jaws under lip of seat insert.



A7381-1C

2. Rotate top nut clockwise to remove insert.

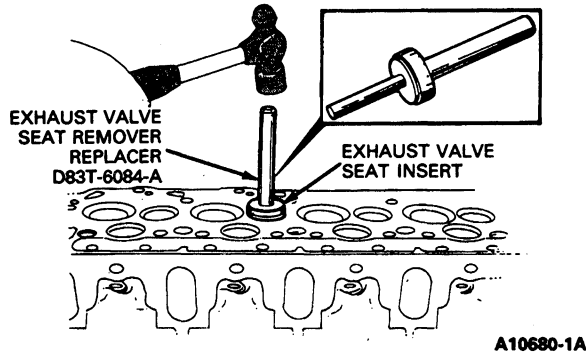
If an oversize seat insert is required, the cylinder head should be sent out to a qualified machine shop for insert counterbore procedure.

DISASSEMBLY AND ASSEMBLY (Continued)

Valve seat inserts supplied for service are standard size, .015 inch oversize and .030 inch oversize.

Exhaust Seats, Installation

1. Install valve seat using Exhaust Valve Seat Remover / Replacer D83T-6084-A or equivalent and a hammer.

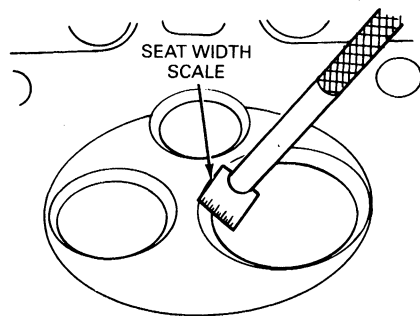


Refacing Valve Seats

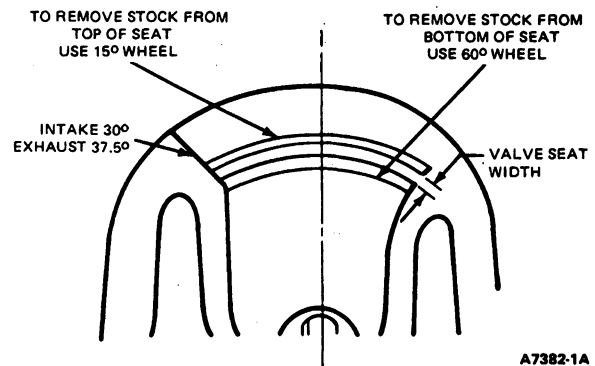
Refacing of valve seat should be closely coordinated with refacing of valve face so that finished seat and valve face will be concentric and specified interference fit will be maintained. This is important so that valve and seat will have a compression tight fit. Make sure that valve seat grinding wheels are properly dressed.

Grind valve seats to specification listed at the end of this section. Remove only enough stock to clean up pits and grooves or to correct valve seat runout. After seat has been refaced, use seat width scale or machinist's scale to measure seat width. Narrow seat if necessary to bring it within specification. Refer to specifications listed at the end of this section.

If valve seat width exceeds maximum limit, remove enough stock from top edge and / or bottom edge of seat to reduce width to specification.



Use a 60 degree angle grinding wheel to remove stock from bottom of seats (raise seats) and use a 15 degree angle wheel to remove stock from top of seats (lower seats).

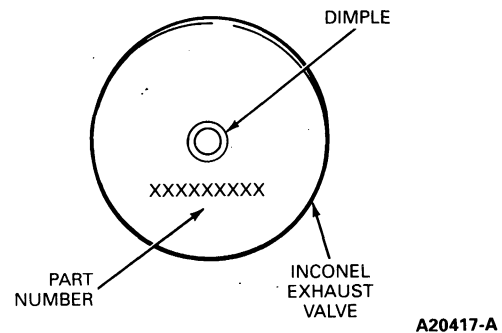


Finished valve seat should contact approximate center of valve face. It is good practice to determine where valve seat contacts face. To do this, coat seat with Prussian blue and set valve in place. Rotate valve with light pressure. If blue is transferred to center of valve face, contact is satisfactory. If blue is transferred to top edge of valve face, lower valve seat. If blue is transferred to bottom edge of valve face, raise valve seat. **Fit of valve and seat should never be lapped out with lapping compounds.**

Valves

Inspect valve for evidence of burning, warping, scuffing or bending. Minor pits, grooves, etc., may be removed. Discard valves that are severely damaged, if face runout cannot be corrected by refinishing, or if stem clearance exceeds specifications. Refer to specification.

Discard any worn or damaged valve train parts.



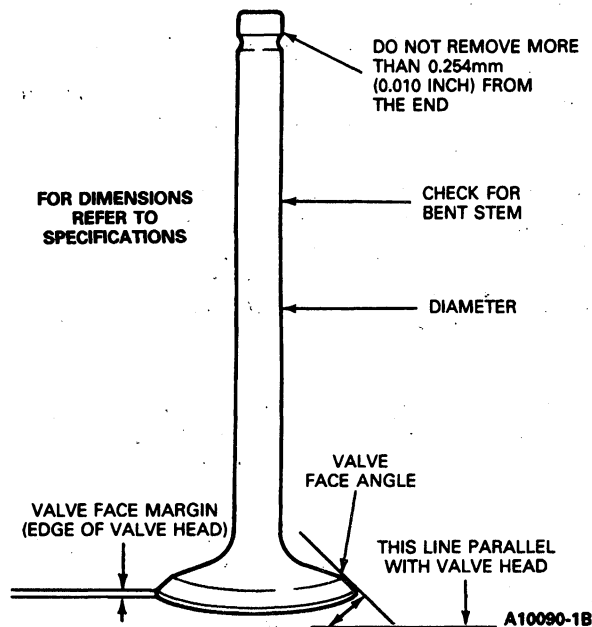
Refacing Valves

The valve refacing operation should be closely coordinated with valve seat refacing operations so that finished angles of valve face of valve seat will be to specifications and provide a compression tight fit. Be sure that valve grinding wheels are properly dressed.

DISASSEMBLY AND ASSEMBLY (Continued)

If valve face runout is excessive and / or to remove pits and grooves, reface valves to specification. Remove only enough stock to correct runout or to clean up pits and grooves. If edge of intake valve head is less than 2.84mm (0.112 inch) thick after grinding, replace valve as valve will run too hot in engine. If edge of exhaust valve head is less than 1.35mm (0.053 inch) thick after grinding replace valve. **Interference fit of valve and seat should not be lapped out.**

Critical Valve Dimensions



Remove all grooves or score marks from end of valve stem, and chamfer it as necessary. **Do not remove more than 0.254mm (0.010 inch) from end of valve stem.**

Assembly

NOTE: To avoid erroneous readings, remove precombustion chamber inserts prior to inspection of cylinder head gasket surface.

1. Clean and inspect cylinder head and valves, as outlined.
2. Clean and inspect cylinder head gasket surface for cracks and flatness, as outlined.
3. Install valves, springs, retainers and stem seals, as outlined.
4. Clean and inspect prechambers and ports for cracks. Install or replace prechambers as necessary. Refer to Overhaul, Cylinder Head Assembly in this section.
5. Apply a light coating of Steering Linkage Lube D4AZ-19590-A (ESA-M1C92-A) or equivalent to mounting edge of prechamber and install prechamber into head. Lightly tap with plastic-tipped hammer, if necessary.
6. Clean and inspect engine block head gasket surface for cracks and flatness.

Cylinder Block

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs, following procedures outlined.

Disassembly

1. Mount engine in a work stand using Rotunda Engine Stand Mounting Adapters 014-00306 or equivalent. Completely disassemble engine following procedures described under Removal and Installation in this section.
2. Remove cylinder ridge with a razor knife or equivalent. Carefully scrape ridge away.
3. Remove cylinder head locating dowels and block drain plugs.

Refinishing Cylinder Walls

NOTE: It is NOT necessary to remove crankshaft, however, it is good practice to oil the rod journals and wrap them in a shop towel with tape.

1. To refinish cylinder walls, obtain a "flexhone" for a 4-inch bore engine with a 120 grit rating (no color code). This type of hone looks like a bristle brush with carbide balls on the ends of the bristles. Obtain a full 12-ounce container of Ford Rust Penetrant and Inhibitor D7AZ-19A501-AA (ESR-M99C56-A) or equivalent. This spray contains colloidal graphite and has a black appearance. Obtain an electric or air-powered drill motor with adjustable speed. A speed of about 100 rpm is required. If this is not available, **REPAIR WILL NOT BE SUCCESSFUL.**
2. Spray cylinder wall and hone cylinder wall for about three seconds while stroking up and down twice a second. Remove the hone (**ALWAYS REMOVE WITH HONE ROTATING**), and wipe a portion of cylinder wall. Inspect the crosshatch pattern comparing it to the neighboring (untouched) cylinder. The crosshatch angle should be 120 to 135 degrees.

Comparison with a "virgin" bore is the best check, provided the engine has not been repaired before. If the pattern is "flatter" than called for, increase stroke speed or slow down rotation speed. The hone will not damage the piston cooling jet and honing to the very bottom of the cylinder is not required as the piston ring travel stops well short of the bottom of the bore. The hone must be partly removed from the block at the top of each stroke.

Continue honing the cylinder (after adjusting your technique to get required 120 to 135 degrees crosshatch) for 10 to 15 seconds, while an assistant continuously sprays the graphite spray at the cylinder wall. Do not spend more than 15 seconds (25 strokes) per bore. Wipe cylinder bore clean and inspect. The bore should have a satin-like sheen with a clearly identified crosshatch pattern of 120 to 135 degrees. Compare with a virgin bore to confirm correct angle. Repeat for remaining cylinders.

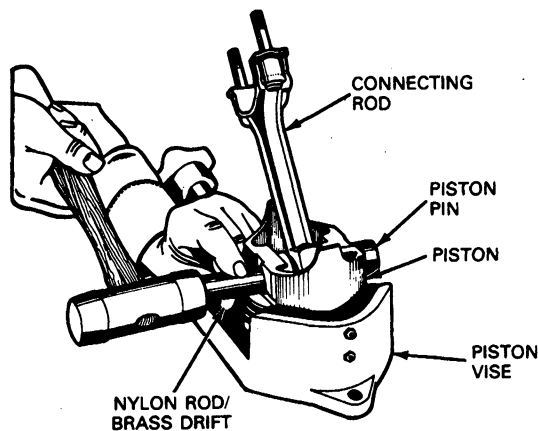
3. Wash all cylinders with mild soap and water (like dishwashing solution). Air dry with shop air and immediately oil cylinder walls to prevent corrosion.

DISASSEMBLY AND ASSEMBLY (Continued)**Assembly**

1. Clean gasket and seal surfaces of all serviceable parts and assemblies with a suitable solvent and dry thoroughly.
2. Position cylinder block in a work stand and install cylinder head locating dowels and block drain plugs.
3. Transfer all serviceable parts removed from original cylinder block following procedures described under Removal and Installation in this section.
4. Check all assembly clearances. Make sure that clearances are in accordance with Specifications at the end of this section. Service as necessary.

Piston and Connecting Rod Assembly**Disassembly**

1. Remove bearing inserts from connecting rod and cap.
2. Mark pistons to assure assembly with same rod and installation into cylinders from which they were removed.
3. To disassemble connecting rod from piston and piston pin assembly, remove piston pin retainers from each end of pin using appropriate pliers.
4. After placing piston in vise, push pin from assembly using drift and hammer or equivalent, or brass drift and plastic-tipped hammer.



A10676-1A

5. After pin is removed, separate piston from connecting rod. Remove all old rings from piston. Clean and inspect components as described in this section.

Fitting Pistons

Refer to Section 03-00, Engine Service, Gasoline in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual. This procedure is the same for diesel and gasoline engines.

CAUTION: Special "patch" bolts are used to install piston cooling jets. These bolts are included with new cooling jets. DO NOT use standard bolts.

Fitting Piston Pins

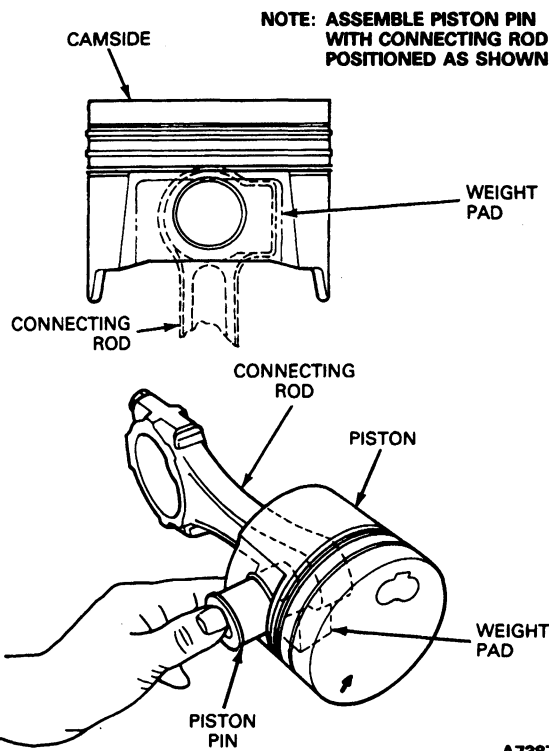
Refer to Section 03-00, Engine Service, Gasoline in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual. This procedure is the same for diesel and gasoline engines.

Fitting Rings

Refer to Section 03-00, Engine Service, Gasoline in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual. This procedure is the same for diesel and gasoline engines.

Assembly

1. To assemble piston to connecting rod, position rod into piston so that connecting rod weight pad is located opposite of the camside.

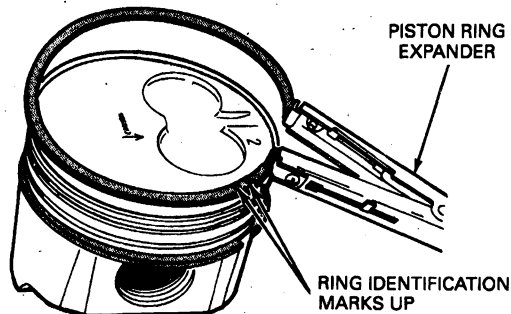


A7387-1B

2. Lubricate piston pin with specified engine oil. Align rod bore and piston bore and insert piston pin. Push piston pin with thumb and install retainer snap rings. Make sure that retainer rings seat fully in their grooves.

DISASSEMBLY AND ASSEMBLY (Continued)

- After checking piston ring end gap, assemble rings onto pistons to which they were fitted by using a suitable ring expander tool. This type of tool is recommended to avoid over-expansion of rings, and also to expand rings to a true circle to avoid distortion.



IMPORTANT: INSTALL IN ORDER:
OIL CONTROL RING,
2ND COMPRESSION RING AND
TOP COMPRESSION RING.
SPACE RING GAPS 120° APART. A10682-B

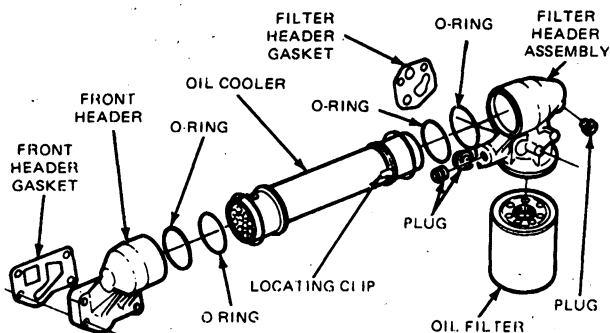
Oil Cooler

If oil is found in the cooling system, or coolant found in the oil, the oil cooler should be checked for leakage as outlined.

If oil cooler O-rings are leaking, remove oil cooler as outlined. Disassemble and repair as follows.

Disassembly

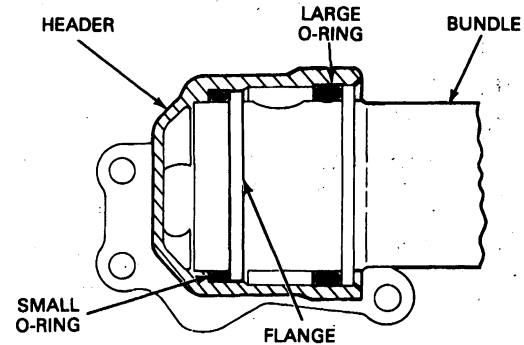
- Gently rap front and oil filter headers to loosen O-rings. Twist oil cooler apart.
- Clean oil cooler, front header and filter header thoroughly in suitable solvent. The oil cooler should be thoroughly flushed and drained to remove all residue within it.



A7422-1B

Assembly

- Use new O-rings when assembling oil cooler. Lubricate all O-ring mating surfaces and O-rings prior to assembly with clean engine oil.
- Install the large O-rings on the oil cooler bundle first, then install the small O-rings on the cooler bundle.



NOTE:
INSTALL THE LARGE O-RING ON THE OIL
COOLER BUNDLE FIRST, THEN INSTALL THE SMALL
O-RING ON THE COOLER BUNDLE.

A8704-C

- Press assembly together making sure locating clips align in slots and header is not cocked.
- Test oil cooler assembly, as outlined before installing on engine.

ADJUSTMENTS

Refer to Section 20A Diesel Diagnosis, 7.3L IDI Turbo Engine in this Supplement for adjustment procedures.

CLEANING AND INSPECTION

Crankcase Depression Regulator (CDR)

Refer to Truck Pre-Delivery, Maintenance and Lubrication Manual for the correct mileage interval for maintenance. Service following procedures described in this section.

Valve Rocker Arm Assembly

Cleaning

Clean all parts thoroughly.

Inspection

Inspect pad at valve end of rocker arms for indications of scuffing or abnormal wear. If pad is grooved, replace rocker arm. **Do not attempt to true this surface by grinding.** Check fulcrum and spherical pushrod seats for excessive wear, cracks, nicks or burrs. Inspect fulcrum seat of rocker arm post for excessive wear.

Push Rods

Refer to Section 03-00, Engine Service, Gasoline in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual. This procedure is the same for diesel and gasoline engines.

Cylinder Heads

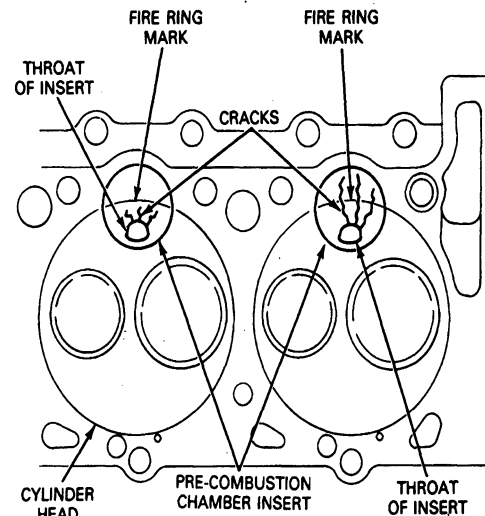
Cleaning

With valves installed to protect the seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. **Be careful not to damage cylinder head gasket surface.** After valves are removed, clean valve guide bores with a valve guide cleaning tool. Use cleaning solvent to remove dirt, grease and other deposits; clean all bolt holes; ensure valve seats, gasket surfaces and oil return passages are clean. Clean all valve assembly components using a suitable solvent and dry thoroughly.

Inspection

NOTE: Precup insert cracking is acceptable from the throat of the precombustion chamber. The cracking becomes unacceptable if the cracks extend beyond the fire ring. Acceptable and unacceptable precup cracks are illustrated. Replace unacceptable precombustion chambers.

1. Examine cylinder head for cracks in combustion chambers, intake and exhaust valve ports, and around intake valve seats. Inspect exhaust valve seat inserts for looseness burned or cracked condition. Inspect gasket and sealing surfaces for scratches or mars which may cause leakage after assembly.



ACCEPTABLE

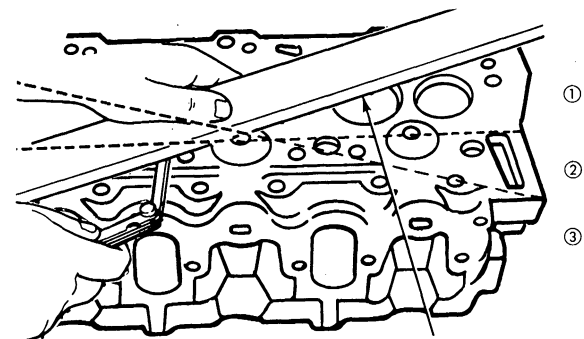
UNACCEPTABLE
CRACKS EXTEND BEYOND
FIRE RING MARK

A8707-1B

NOTE: Cylinder heads cannot be resurfaced.

2. Using a straightedge and a 0.15mm (0.006 inch) feeler gauge, check cylinder head gasket surface for warpage.

Replace cylinder head if it is cracked or warped.



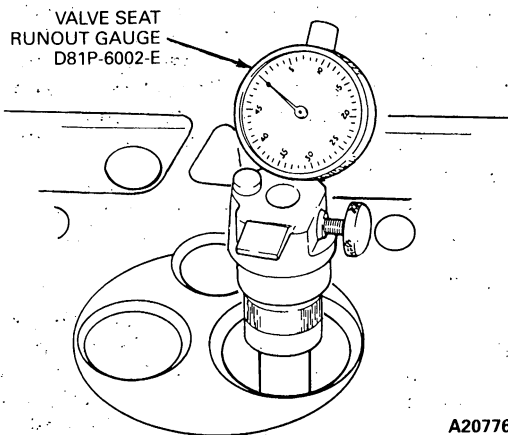
- ① ③ CHECK DIAGONALLY
- ② CHECK ACROSS CENTER

STRAIGHT EDGE
D83L-4201-A

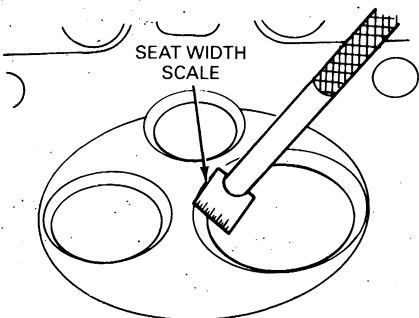
A20475-A

CLEANING AND INSPECTION (Continued)

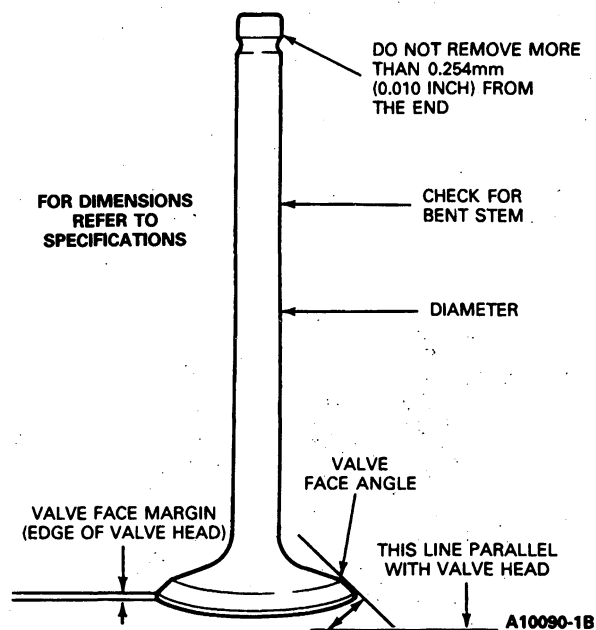
3. Check valve seat runout with suitable valve seat runout gauge. Follow instructions of gauge manufacturer. If runout exceeds service limit, reface valve and valve seat.



4. Measure valve seat width. Reface valve seat(s) as outlined in this section if width is not within specifications.

**Valves****Visual Inspection**

Critical inspection points and tolerances of valve are illustrated. Refer to Specifications at the end of this section for service limits. Remove all carbon from valve stems and valve heads using a fine wire brush or buffing wheel.



Inspect valve face and edge of valve head for pits, grooves or scores. Inspect stem for a bent condition and end of stem for grooves or scores. Check valve head for signs of burning or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

Visually inspect valve springs, valve spring retainers, locks and sleeves and discard any damaged parts.

Inspect valve keepers for excessive wear and replace in pairs as required. When installing a new valve, always use new valve keepers.

Valve Face Runout

Check valve face runout. It should not exceed specifications listed at the end of this section. If runout exceeds service limit, valve should be replaced or refaced as described under Refacing Valves.

Valve Stem Clearance**TOOLS REQUIRED**

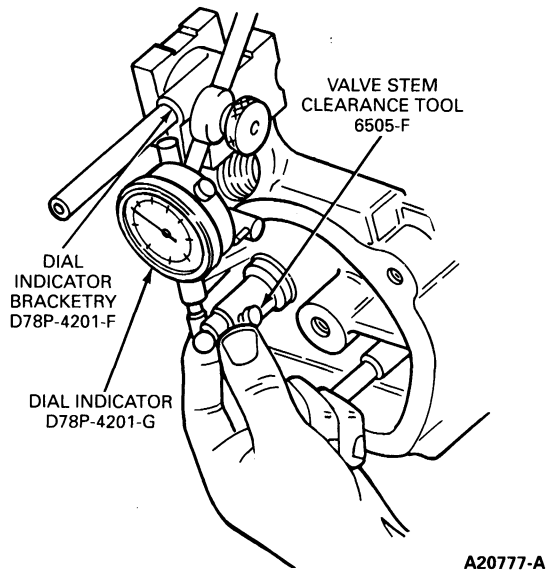
Description	Tool Number
Valve Stem Clearance Tool	TOOL-6505-F

Check valve stem to valve guide clearance of each valve in its respective valve guide with Valve Stem Clearance TOOL-6505-F (3/8 valves); Dial Indicator D78P-4201-G, and Dial Indicator Bracket D78P-4201-F or equivalents. Use a flat end indicator point.

Install tool onto valve stem until fully seated, and tighten knurled set screw firmly. Permit valve to drop away from its seat until tool contacts upper surface of valve guide.

CLEANING AND INSPECTION (Continued)

Position dial indicator with its flat tip against center portion of tool's spherical section at approximately 90 degrees to valve stem axis. Move tool back and forth in line with indicator stem. Take a reading on dial indicator without removing tool from valve guide upper surface. Divide reading by two, the division factor for tool. If valve stem to valve guide clearance exceeds specifications listed at the end of this section, install new valve guide as outlined in this section.



Valve Spring Pressure

Refer to Section 03-00, Engine Service, Gasoline in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual. This procedure is the same for diesel and gasoline engines.

Valve Spring Squareness

Refer to Section 03-00, Engine Service, Gasoline in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual. This procedure is the same for diesel and gasoline engines.

Intake Manifold

Cleaning

Remove all gasket material from machined surfaces of manifold. Clean manifold in a suitable solvent and dry with compressed air.

Inspection

Inspect manifold for cracks, nicked gasket surfaces, or other damage that would make it unfit for further service. Inspect cylinder head mounting faces of manifold with a straight edge for warpage. Replace manifold if warped or cracked.

Exhaust Manifolds

Cleaning

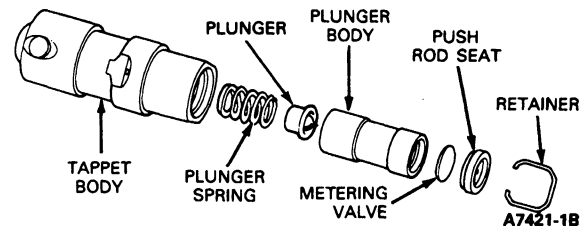
Clean manifold mating surfaces.

Inspection

Inspect manifold(s) for cracks, damaged gasket surfaces, or other wear or damage that would make them unfit for further service. Inspect cylinder head joining flanges of exhaust manifold(s) for evidence or warpage with a straight edge. Minor warpage can be corrected by surface grinding. If warpage is extreme, replace manifold.

Hydraulic Valve Tappets

Valve tappet assemblies should be kept in proper sequence to permit installation into original position. Inspect and test each tappet separately to prevent intermixture of internal parts. **If any part of tappet assembly needs replacing, replace the entire assembly.**



Disassembly

1. Remove plunger retainer with small screwdriver.
2. Remove push rod seat and metering valve.
3. Remove plunger and plunger spring.

Cleaning

Thoroughly clean all parts in clean solvent and wipe with a clean, lint-free cloth.

Inspection

Inspect parts and discard the entire tappet assembly if any part shows pitting, scoring, galling or evidence of non-rotation. Replace entire assembly if the plunger is not free in body. Plunger should drop to bottom of body by its own weight when assembled dry.

Roller should rotate freely, without excessive play. Check for missing or broken needle bearings. Roller should be free of pits or roughness. If present, inspect camshaft lobes for similar condition. If pits or roughness are evident, replace cam follower and camshaft.

Assembly

1. Coat all parts with specified engine oil.
2. Install plunger spring and plunger into tappet body.

CLEANING AND INSPECTION (Continued)

3. Install metering valve and push rod seat into tappet body and install retaining ring.
Check for free operation by pressing down on the push rod cup. Tappets can also be checked with a hydraulic tester to test leak-down rate. Follow instructions provided with test unit.

Camshaft

Clean camshaft in solvent and wipe dry. Inspect camshaft lobes for scoring and signs of abnormal wear. Camshaft should not be replaced unless camshaft lobe lift loss has exceeded specifications.

Check camshaft lobe lift with camshaft installed in engine or on centers. Refer to Static (Engine Off) Valve Train Analysis under Diagnosis and Testing.

Check fuel pump eccentric for excessive wear.

Drive Gears

Cleaning

Clean gears in solvent and dry with compressed air.

Inspection

Inspect gear teeth for scores, nicks, etc. Note condition of tooth contact pattern. If teeth are scored, replace gears.

It is not necessary to replace gears in sets. Replace damaged gears and check backlash, runout, etc., as described in this section, to determine if any other gear should be replaced.

Crankshaft Vibration Damper

Cleaning

Clean oil seal contact surface on crankshaft damper sleeve with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits not readily removable with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges, burrs or other imperfections which might damage oil seal during installation or cause premature seal wear. **Do not use crocus cloth to the extent that seal surface becomes polished. A finely polished surface may produce poor sealing.**

Inspection

Inspect crankshaft vibration damper sleeve oil seal surface for nicks, sharp edges or burrs that might damage oil seal during installation.

Crankshaft

Cleaning

Handle crankshaft with care to avoid possible fractures or damage to finish surfaces. Clean crankshaft with solvent, and blow out all oil passages with compressed air.

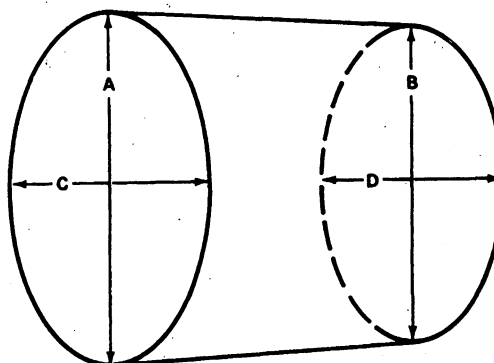
Clean oil seal contact surface at rear of crankshaft with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits not readily removable with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges, burrs or other imperfections which might damage oil seal during installation or cause premature seal wear. **Do not use crocus cloth to the extent that seal surfaces become polished. A finely polished surface may produce poor sealing.**

Inspection

Inspect main and connecting rod journals for cracks, scratches, grooves or scores.

Measure diameter of each journal in at least four places to determine out-of-round, taper or undersize condition.

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

A10094-1A

Bearing failures can cause overheating of crankshaft journals and a reduction of hardness. When this occurs, the crankshaft strength may be unacceptably reduced. Whenever bluing is found on the journal or fillet area, the crankshaft must be replaced.

Crankshafts must not be straightened. Even slight straightening with complete absence of cracks will endanger the high strength built into the shaft.

Flywheel

Automatic Transmission

Inspection

Inspect flywheel for cracks or other damage that would make it unfit for further service. Inspect starter ring gear for worn, chipped or cracked teeth. If teeth are damaged, replace flywheel.

CLEANING AND INSPECTION (Continued)

With flywheel installed on crankshaft, check gear face runout of flywheel (refer to Diagnosis and Testing in this section).

Manual Transmission

Inspection

Inspect flywheel for cracks, heat checks, or other damage that would make it unfit for further service. Machine friction surface of flywheel if it is scored or worn. If it is necessary to remove more than 1.016mm (0.040 inch) of stock from original thickness, or if flywheel thickness is less than 14mm (0.55 inch) after refacing, replace secondary flywheel. If necessary, refer to Secondary Flywheel Removal and Installation.

CAUTION: Installation of a flywheel less than 14mm (0.55 inch) thick can cause primary flywheel damage.

Inspect ring gear for worn, chipped, or cracked teeth. If teeth are damaged, replace ring gear.

With flywheel installed on crankshaft, check flywheel face runout, following procedure described under Diagnosis and Testing.

Main and Connecting Rod Bearings

Refer to Section 03-00, Engine Service, Gasoline in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual. This procedure is the same for diesel and gasoline engines.

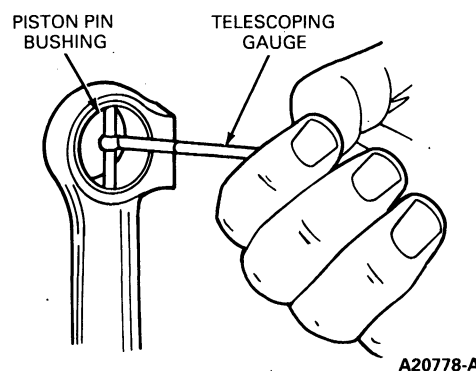
CAUTION: In the event of bearing failure, the oil cooler must be disassembled and the tube bundle must be replaced.

Connecting Rods

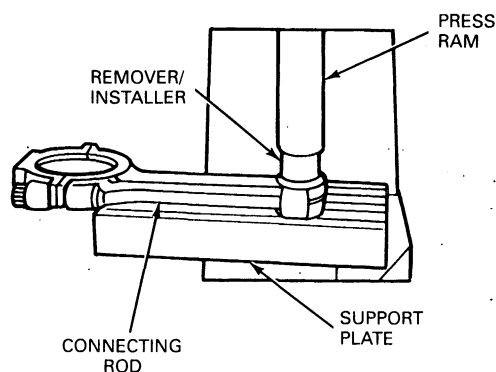
Inspection

NOTE: Piston pin bushings can be serviced using ZTSE-4154 Tool Kit which can be purchased from Owatanna Tool Company at OTC Division, SPX Corporation, 655 Eisenhower Drive, Owatanna, MN 55060 or call 1-800-533-5338.

1. Measure the inside diameter of the piston pin bushing using a telescoping gauge and a micrometer. If piston pin bushings are out of specification, new bushings must be installed.



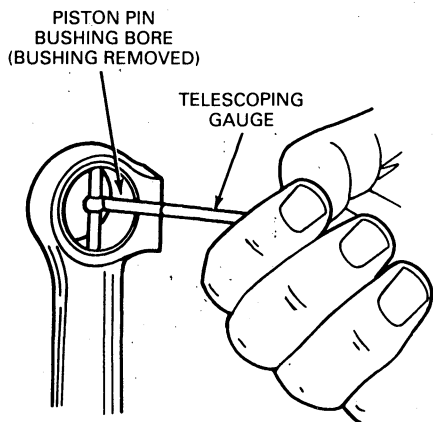
2. Remove any worn bushing using Connecting Rod Bushing Remover and Installer Tool ZTSE-4154.
3. Place the connecting rod under a hydraulic press in line with the properly-sized hole on the support block and use ZTSE-4154 to press out the bushing.



4. Clean the connecting rod thoroughly and visually inspect for defects.

CLEANING AND INSPECTION (Continued)

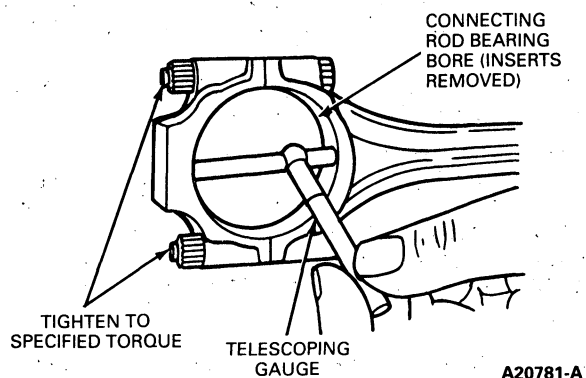
5. Using a telescoping gauge and a micrometer, check the connecting rod piston pin bushing bore diameter.



A20780-A

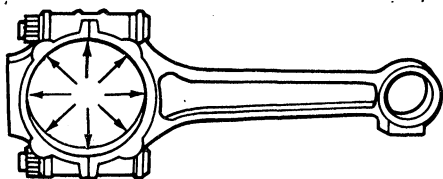
NOTE: Measure bore diameter with connecting rod nut tightened to specified torque. Replace as required.

6. Inspect the crankshaft end as follows:
- Measure connecting rod bearing bore diameter.



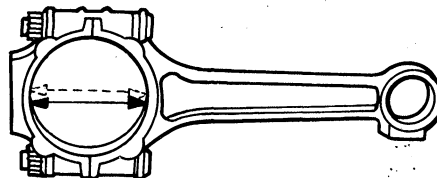
A20781-A

- With the connecting rod assembled and rod bolts and nuts tightened to specification, use a dial bore gauge indicator to measure out-of-round. Replace rod if maximum out-of-round specification is exceeded. Refer to Specifications at the end of this section.



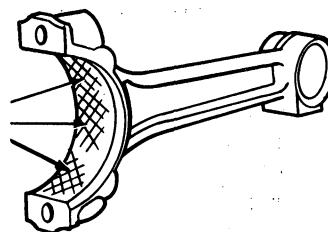
A20782-A

- Measure the connecting rod bore taper, by measuring the bore I.D. near the large chamfer, record reading and measure the bore I.D. near the small chamfer, record reading. The difference between the two readings is the bore taper. Replace rod if maximum bore taper is exceeded.



A20783-A

- With the connecting rod cap removed, visually inspect the surface finish of the connecting rod bearing bore. The bore must be smooth and free of scoring or nicks.



A20784-A

7. An engine component wear pattern can be identified and used to diagnose a problem. Following are common examples of connecting rod wear pattern diagnostic hints:

- A shiny surface on the edge of the piston pin bushing usually indicates that a connecting rod is bent or a piston pin hole is not in proper relation to piston skirt and ring grooves.
- Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, an improperly machined journal, or a tapered connecting rod bore.
- Twisted connecting rods will not create an easily identifiable wear pattern, but badly twisted rods will disturb the action of the entire piston, rings, and connecting rod assembly and may be the cause of excessive oil consumption.

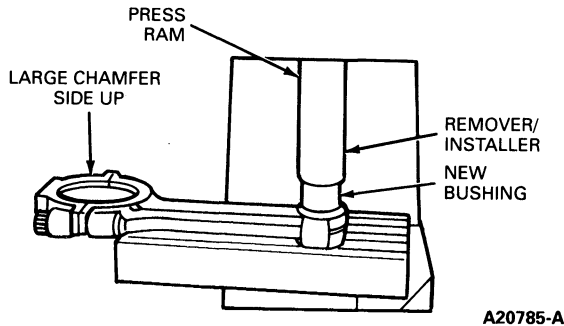
Assembly

NOTE: The clinch joint (split) in the bushing must be located in the connecting rod as illustrated.

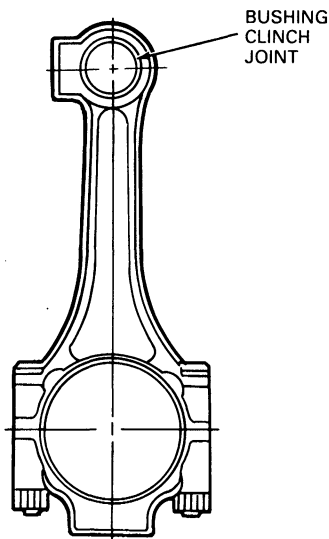
- Install a new connecting rod bushing using installer tool ZTSE-4154 as follows:
 - Place the new bushing on the remover/installer tool ZTSE-4154 and lubricate the bushing O.D. with clean engine oil.

CLEANING AND INSPECTION (Continued)

- b. Place the connecting rod on a flat surface plate with the "large" chamfer side of the main bearing bore up.
- c. Press the new bushing in place flush or below the surfaces of both sides of the rod.



2. After the bushing has been installed in the rod, it must be honed to the proper I.D. Refer to Specifications at the end of this section.



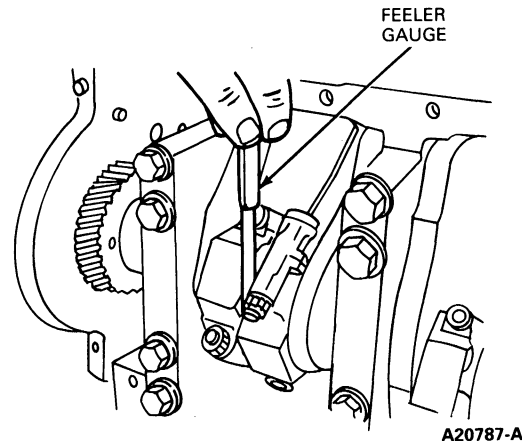
A20786-A

NOTE: The connecting rod end clearance must be checked to be certain that the specified clearance exists.

Lack of clearance could indicate a damaged rod or a rod bearing out of position. Correct as required.

Excessive clearance may require replacement of the rods or crankshaft.

3. Check the connecting rod side clearance, using a feeler gauge.



A20787-A

Pistons, Pins and Rings**Cleaning**

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins, and rings with solvent.

CAUTION: Do not use a caustic cleaning solution or a wire brush to clean pistons.

Clean the ring grooves by breaking the old compression ring and using the good edge to clean out any varnish or deposits. Use the top compression ring to clean the top ring groove and the second compression ring to clean the second ring groove because they are different keystone designs.

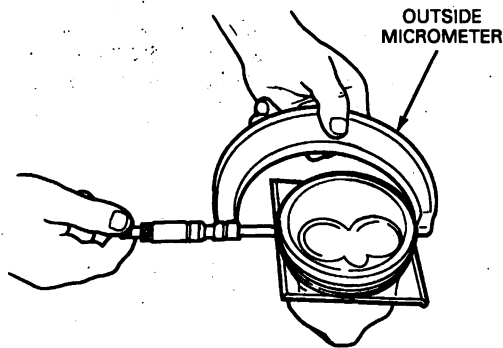
Inspection

Carefully inspect the pistons for fractures at the ring lands, skirts, oil ring slot corners, and pin bosses, and for scuffed, rough or scored skirts. If the lower inner portion of the ring grooves have a high step, replace the piston.

Check keystone piston ring groove wear. Gauge pins can be made locally to measure ring groove wear. Two 0.115-inch gauge pins will be required to measure top ring groove wear and two 0.098-inch gauge pins will be required for the bottom compression ring groove. Gauge pins are available from OTC tool company.

CLEANING AND INSPECTION (Continued)

Install the gauge pins in the appropriate groove and measure diameter with an outside micrometer. The acceptable range for the top compression ring groove is 4.097-4.130 inches. The acceptable range for the bottom compression ring groove is 4.135-4.160 inches. If either specification is not in the acceptable range, replace the piston. Check piston ring end gap.



A20418-A

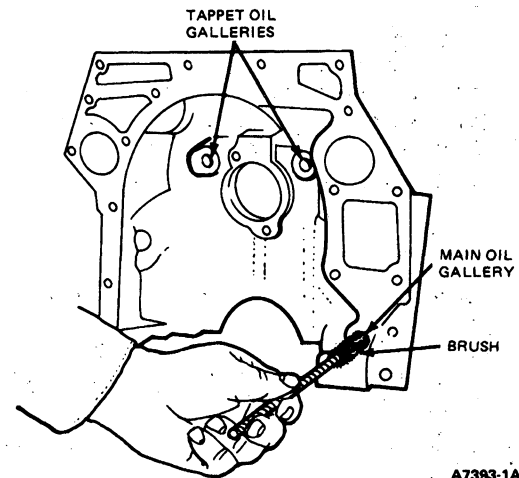
A shiny surface on the thrust surface of the piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear, wavy ring lands or fractures or damage.

Check the piston-to-cylinder bore clearance by measuring the piston and bore diameters. Refer to Specifications for the proper clearance. Refer to Cylinder Block Inspection for the bore measurements procedure. Measure the outside diameter of the piston and check the ring side clearance.

Replace piston pins showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod.

Check the outside diameter of the piston pin and the inside diameter of the pin bore in the piston. Replace any piston pin or piston that is not within specifications. Refer to Specifications in this section.

CAUTION: Extreme care must be used when cleaning grooves on aluminum pistons.



A7393-1A

Remove valve tappet oil gallery plugs by drilling small hole in plug and prying with a screwdriver or suitable tool. Clean tappet oil galleries with a 8mm (5/16-inch) brush. Replace tappet gallery plugs flush to 1.52mm (.060-inch) below crankcase surface as outlined.

Make sure threads in cylinder head bolt holes are clean. Dirt in threads may cause binding and result in false torque readings. Use tap to true-up threads and to remove any deposits.

Oil Pan**Cleaning**

Scrape any dirt or metal particles from inside of pan. Scrape or wire brush all old gasket material from gasket surface. Wash pan in a degreasing solvent and dry it thoroughly. Make sure all foreign particles are removed from below baffle plate.

Inspection

Check pan for cracks, holes and damaged drain plug threads. Check gasket surface for damage caused by over-tightened bolts. Straighten surface as required to restore original flatness.

Replace pan if repairs cannot be made.

Cylinder Block**Cleaning and Inspection**

These procedures are the same for diesel and gasoline engines except for the additional following steps for diesel engines.

Remove main oil gallery plug and use a 9.5mm (3/8-inch) diameter brush to clean main oil gallery. Replace oil plug after coating with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent non-hardening sealing compound.

Oil Pump

Check oil pump drive gear backlash as outlined in this section. If backlash is out of specification, replace pump. Oil pump is serviced as a complete assembly only.

CLEANING AND INSPECTION (Continued)**Fuel Supply Pump**

Inspect fuel supply pump for cracks or damage. Inspect mounting flange for distortion. Inspect rocker arm spring, pin and rocker arm for wear, cracks or damage. **If any fuel supply pump components are damaged, replace fuel supply pump.**

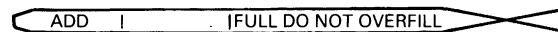
Thermostat

To check operation, place thermostat in a pan of water, heat water, and, using an accurate thermometer, observe water temperature when thermostat starts to open. Thermostat should start to open at approximately 100-107°C (180-192°F) and be fully open at approximately 111-118°C (200-212°F). The thermostat is not adjustable. If it does not operate within above limits, replace it.

If problem being investigated is insufficient heat, thermostat should be checked for leakage. This may be done by holding thermostat up to a lighted background. Light leakage around thermostat valve (thermostat at room temperature) is unacceptable, and thermostat should be replaced.

Engine Oil Level

Check crankcase oil level each time you stop for fuel. Keep the oil level between the FULL and ADD marks on the dipstick. The distance between the ADD and FULL marks on the diesel engine represents two quarts. **DO NOT OVERFILL.**



F-SERIES

A20419-A

Engine Fuel Filter

Refer to Owner Guide or Section 00-03, Maintenance and Lubrication in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.

Accelerator Linkage

Check accelerator linkage for sticking or binding. Make sure that throttle lever returns to the idle stop on the injection pump. Service as necessary. Lubricate friction points as specified in Section 00-03, Maintenance and Lubrication in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual.

SPECIFICATIONS

Refer to the following charts for specifications.

GENERAL SPECIFICATIONS

Engine	Bore and Stroke	Firing Order	Oil Pressure Hot @ 3300 RPM kPa (PSI)	Engine Type and Number of Cylinders	Compression Ratio
7.3L Diesel (444 CID)	4.11 in. x 4.18 in.	1-2-7-3-4-5-6-8	276-482 kPa (40-70)	O.H.V. V-8	21.5 to 1

SPECIFICATIONS (Continued)

CYLINDER HEAD

Engine	Pre-Chamber Insert Protrusion	Valve Guide Bore Diameter		Valve Seat Width ^a		Valve Seat Runout TIR Maximum	Valve Arrangement Front to Rear	Gasket Surface Flatness ^b
		Intake	Exhaust	Intake	Exhaust			
7.3L Diesel V-8	-0.0025 In. +0.0025 In. (-0.064mm/ +0.064mm)	0.3736 In. 0.3746 In.	0.3736 In. 0.3746 In.	0.065 In.- 0.095 In. (1.651- 2.413mm)	0.065 In.- 0.095 In. (1.651- 2.413mm)	0.002 In. (0.05mm)	LT I-E-I-E-I-E-I-E RT E-I-E-I-E-I-E-I	0.003 In. (0.0762mm) in Any 6 Inch 0.006 In. (0.1524mm) Overall

a Valve seat angle — intake 30° and Exhaust 37.5°.

b Gasket surface finish — RMS 60-150.

VALVE ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

Engine	Type	Push Rod Runout TIR Maximum	Valve Tappet or Lifter			Collapsed Tappet Gap (Clearance) ^c
			Standard Diameter	Clearance to Bore ^a	Hydraulic Lifter Leakdown Rate ^b	
7.3L Diesel V-8	Hydraulic Roller Follower	0.015 In.	0.9209 In.- 0.9217 In. (23.391- 23.411mm)	0.0011 In.- 0.0034 In. (0.027- 0.086mm)	20-110 Sec. for 0.125 In. Travel	0.185 Max.

a Service Limit — .005.

b Time required for plunger to leakdown .125 in. under load of 50 lbs. using leakdown fluid in tappet.

c Measured at valve tip to rocker arm.

VALVE SPRINGS

Engine	Valve Spring Compression Pressure Lbs. @ Specified Height		Valve Spring Free Length (Approximate)		Valve Spring Assembled Height		Valve Spring Out of Square Maximum
	Intake ^a	Exhaust	Intake	Exhaust	Intake	Exhaust	
7.3L Diesel V-8	200 @ 1.397	200 @ 1.397	2.075 In. ± 0.150 In. (52.705mm ± 3.8mm)	2.075 In. ± 0.150 In. (52.705mm ± 3.8mm)	1.767	1.833	5/64 (0.078)

a Service Limit — ±8 lbs.

VALVES

Engine	Valve Stem to Guide Clearance ^a		Valve Face Angle		Valve Face Runout TIR Maximum
	Intake	Exhaust	Intake	Exhaust	
7.3L Diesel V-8	0.0055 In. (0.140mm)	0.0055 In. (0.140mm)	30°	37.5°	0.0015 In. (0.0381mm)

a Service clearance — .0055.

VALVES (Continued)

Engine	Minimum Valve Face Margin-Intake Valves	Minimum Valve Face Margin — Exhaust Valves
7.3L Diesel V-8	0.112 Inch (2.84mm)	0.053 Inch (1.35mm)

VALVES (Continued)

Engine	Valve Stem Diameter		Valve Head Recession Relative To Deck Surface	
	Intake	Exhaust	Intake	Exhaust
7.3L Diesel	.37165-.37235	.37165-.37235	.042-.054 In. (1.06-1.37mm)	.051-.063 In. (1.29-1.60mm)

SPECIFICATIONS (Continued)

CAMSHAFT

Engine	Camshaft End Play		Camshaft Journal to Bearing Clearance
	End Play	Service Limit	
7.3L Diesel	.002-.009 Inch (.025-.228mm)	—	0.0381-0.0889mm (0.0015-0.0035 In.)

CAMSHAFT DRIVE

Engine	Camshaft Bearing Inside Diameter ^a					Camshaft Front Bearing Location ^b	Gear Backlash
	No. 1	No. 2	No. 3	No. 4	No. 5		
7.3L Diesel V-8	2.1015-2.1025 Inch (53.37-53.40mm)	2.1015-2.1025 Inch (53.37-53.40mm)	2.1015-2.1025 Inch (53.37-53.40mm)	2.1015-2.1025 Inch (53.37-53.40mm)	2.1015-2.1025 Inch (53.37-53.40mm)	0.020-0.050 Inch	0.0015-0.013 Inch

a All camshaft journals are 2.0990-2.1000.

b Distance in inches that front edge of the bearing is installed below the front face of the cylinder block.

INJECTION PUMP DRIVE GEAR BACKLASH —
0.0055-0.0010

CYLINDER BLOCK

Engine	Cylinder Bore Diameter ^a	Main Bearing Inside Diameter ^b	Head Gasket Surface Flatness	Head Gasket Surface Finish	Oversize	Bore Size
7.3L Diesel	4.1095-4.1115 Inch (104.38-104.43mm)	3.3152-3.3162 In. (84.21-84.23mm)	0.003 Inch in Any 6 In. 0.006 Inch Overall	RMS 63-125	0.010	4.11425 Inch (104.502mm)
—	—	—	—	—	0.020	4.12425 Inch (104.756mm)
—	—	—	—	—	0.030	4.13425 Inch (105.010mm)

a Maximum out-of-round — .002; Maximum taper — 0.002 inch; Cylinder bore surface finish RMS 15-30.

b With bearing caps tightened in place.

CRANKSHAFT AND FLYWHEEL

Engine	Main Bearing Journal Diameter ^a	Main Bearing Journal Runout TIR Maximum ^b	Main Bearing Thrust Face Runout TIR Maximum	Main Bearing Journal Taper Maximum Per Inch	Thrust Bearing Journal Length	Main and Rod Bearing Journal Finish RMS Maximum	Main Bearing Thrust Face Finish RMS Maximum
7.3L Diesel	3.1228-3.1236 In.	0.002 Inch	0.001 Inch	0.0005 Inch	1.1325-1.1355 Inch	5-20	5-20
Undersize 0.010	3.1128-3.1136 In.	—	—	—	—	—	—
Undersize 0.020	3.1028-3.1036 In.	—	—	—	—	—	—
Undersize 0.030	3.0928-3.0936 In.	—	—	—	—	—	—

a Maximum out-of-round — 0.0002.

b Service limit — 0.005.

CRANKSHAFT FLYWHEEL (Continued)

Engine	Connecting Rod Journal Diameter ^a	Connecting Rod Journal Taper Per Inch Maximum	Crankshaft End Play ^b	Flywheel and Ring Gear Runout	Flywheel and Ring Gear Concentricity
7.3L Diesel	2.4980-2.4990 In.	0.0005 In.	0.0025-0.0085 In.	0.030 In.	0.020 In.
Undersize 0.010	2.488-2.489 In.	—	—	—	—

(Continued)

SPECIFICATIONS (Continued)

CRANKSHAFT FLYWHEEL (Continued) (Cont'd)

Engine	Connecting Rod Journal Diameter ^a	Connecting Rod Journal Taper Per Inch Maximum	Crankshaft End Play ^b	Flywheel and Ring Gear Runout	Flywheel and Ring Gear Concentricity
Undersize 0.020	2.478-2.479 In.	—	—	—	—
Undersize 0.030	2.468-2.469 In.	—	—	—	—

a Maximum out-of-round — .0003.

b Service limit — .012.

CRANKSHAFT BEARINGS

Engine	Connecting Rod Bearing to Crankshaft Clearance Selective Fit			Main Bearing to Crankshaft Clearance Selective Fit		
	Desired	Allowable	Bearing Wall Thickness Std.	Desired	Allowable	Bearing Wall Thickness Std.
7.3L Diesel	0.0011-0.0036 In.	0.0011-0.0036 In.	—	0.0018-0.0036 In.	0.0018-0.0046 In.	—

CONNECTING ROD

Engine	Piston Pin Bushing I.D.	Rod Bearing I.D. ^{ab}	Rod Length Center to Center	Connecting Rod Alignment Maximum Total Difference		Rod to Crankshaft Assembled Side Clearance
				Twist ^c	Bend ^c	
7.3L Diesel	1.3086 In.	2.5001-2.5016 In.	7.128-7.132 In.	0.002 In.	0.001 In.	0.012-0.024 In.

a Connecting rod bearing bore maximum out-of-round — .0005 and maximum bore taper — .0005.

b With bearing caps tightened in place.

c Pin bushing and crankshaft bore must be parallel and in same vertical plane within specified total difference when measured at the ends of an 8-inch long bar, 4 inches on each side of rod centerline.

CONNECTING ROD

Engine	Piston Pin Bushing I.D.	Piston Pin Bushing Bore I.D.	Crankpin Bearing Bore Diameter	Bearing Bore	
				Max Out-of-Round	Max Taper Per Inch
7.3L Diesel	1.1105 In.-1.1108 In.	1.235 In.-1.236 In.	2.6905 In.-2.6915 In.	0.0005 In.	0.0005 In.

PISTON

Engine	Skirt Diameter ^{ab} Standard	Piston to Bore Clearance Selective Fit ^c	Piston Pin Bore Diameter	Piston Height Above Crankcase	Oversize
7.3L Diesel	4.10375 In. ± 0.00025 In.	See Note Below	1.308	0.010-0.031	0.010 In. 4.11425 In. ^d
—	—	—	—	—	0.020 In. 4.12425 In.
—	—	—	—	—	0.030 In. 4.13425 In.

a Measured at 90 degrees to the pin, at 1.25 inch below oil ring groove.

b Service piston is 4.10375 in. ± 0.00025 in.

c Clearance in cylinder bores: 0.0055-0.0060 inch.

d Oversize service piston specifications are all ± 0.0005 inch.

PISTON PIN

Engine	Length	Diameter	Ring End Clearance	To Piston Pin Bore Clearance ^a	To Connecting Rod Bushing Clearance
7.3L Diesel	2.692-2.702 In.	1.1099-1.1101 In.	0.001-0.029 In.	0.0003-0.0007 In.	0.0004-0.0009 In.

a Selective fit.

SPECIFICATIONS (Continued)

PISTON RINGS

Engine	Standard Ring Diameters	Ring Groove Wear		Side Clearance ^a Oil	Ring Gap			Oversize
		Compression			Compression		Oil	
		Top	Bottom		Top	Second		
7.3L Diesel	4.11 in. (104.39mm)	4.097- 4.130 in.	4.135- 4.160 in.	0.001- 0.003 in.	0.013- 0.045 in.	0.060- 0.085 in.	—	0.010 in. 4.120 in.
—	—	—	—	—	—	—	—	0.020 in. 4.130 in.
—	—	—	—	—	—	—	—	0.030 in. 4.140 in.

a Service limit — .002 maximum increase in clearance.

Torque Limits — 7.3L IDI Turbo V-8 Diesel Engine

NOTE: Unless otherwise specified, use standard torque chart. Torque values are with threads and washer faces coated with engine oil. Torque values are listed without tolerance. Variations to torque will occur due to torque wrench calibration. Variation should be within 10% of nominal values.

STANDARD TORQUE

1/4x20 UNC	5/16-18 UNC	3/8-16 UNC	7/16-14 UNC	1/2x13 UNC
9.5 N-m (7 Ft-Lb)	19 N-m (14 Ft-Lb)	32 N-m (24 Ft-Lb)	51 N-m (38 Ft-Lb)	81 N-m (60 Ft-Lb)

PIPE THREADS

1/8x27	1/4x18	3/8x18	1/2x14
7-11 N-m (5-8 Ft-Lb)	17-24 N-m (12-18 Ft-Lb)	30-44 N-m (22-33 Ft-Lb)	34-47 N-m (25-35 Ft-Lb)

TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
A/C Compressor Mounting Bracket to Engine	40-55	30-41
Accelerator Cable Bracket to Intake Manifold	16-23	11-17
Air Cleaner Stud Adapter	61 ^a	45
Alternator Bracket to Cylinder Block	54-75	40-55
Alternator Pivot Bolt	72-98	53-72
Alternator Support Bracket to Water Pump	54-75	40-55
Alternator Adjusting Arm to Support	54-75	40-55
Alternator Adjusting Bolt	54-75	40-55
CDR Valve	^b	—
Camshaft Gear Screw	20	15
Connecting Rod Nuts	52	38
Connecting Rod Nuts — Step 2	69	51
Crankcase Front Cover	^b	—

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Crankshaft Pulley	^b	—
Cylinder Head Bolts — Step 1	88	65
Cylinder Head Bolts — Step 2	122	90
Cylinder Head Bolts — Step 3	135	110
Damper to Crankshaft Bolt	122	90
Engine Front Cover Bolts	^b	—
Exhaust Manifold (F-Series)	27	20
Fan Clutch to Water Pump (LH Thread)	61-163	45-120
Fan Shroud Bolts	4-8	35-71 In-Lb
Flywheel to Crankshaft Flange	64 + 45°	47 + 45°
Front A/C Compressor Brace and A/C Mounting Bracket to Rear A/C Compressor Brace	40-55	30-41
Front A/C Compressor Brace to A/C Compressor	40-55	30-41
Fuel Filter Adapter to Bracket	33-52	24-38
Fuel Filter Bracket to Cylinder Block	33-52	24-38
Fuel Filter to Adapter	^c	—
Fuel Filter/Heater/Water Separator Assembly	33-52	24-38
Fuel Line Nuts onto Nozzle	30	22
Fuel Nozzle Line to Injection Pump	30	22
Fuel Outlet Line	20-24	15-18
Fuel Supply Pump	^b	—
Glow Plug	16	12
Heater Hose Fitting to Water Pump	17-24	13-18
Injection Pump Outlet Fitting Nut	30	22
Injection Pump Gear Cover	19 ^a	14
Injection Pump Gear Mounting Bolts	34	25
Injection Pump to Adapter	35	26
Inlet Line/Return Line Nuts	20-24	15-18
Intake Manifold	33	24
Main Bearing Cap Bolts — Step 1	129	95

(Continued)

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Main Bearing Cap Bolts — Step 2	+45°	+45°
Manifold — Exhaust (with Prevailing Torque Bolt)	47 ^b	35
Manifold — Intake	33	24
Manifold — Intake — Step 2	33	24
Nozzle Assembly	47 ^d	35
Nozzle Connector Nut (Injection Pipe)	30	22
Oil Filter to Header Adapter	•	—
Oil Cooler to Cylinder Block	b	—
Oil Cooler Plug	21	15
Oil Pan Drain Plug	37	27
Oil Pan to Cylinder Block	b	—
Power Steering Pump Rear Support Cylinder Head	40-55	30-41
Power Steering Pump Mounting Bracket to Rear Support	53-72	39-53
Power Steering Pump Support to Water Pump	40-55	30-41
Power Steering Pump to Mounting Bracket	40-55	30-41
Pulley to Vibration Damper	b	—
Radiator Hose Clamps (Screw Type)	3-4	27-35 In-Lb
Radiator Hose Clamps (Double Wire)	2-3	18-27 In-Lb
Rear Cover	b	—
Rear A/C Compressor Brace to A/C Compressor	40-55	30-41
Rocker Arm Post Attaching Bolts	27	20
Secondary Flywheel to Primary Flywheel	64	47
Vacuum Pump Mounting Plate to Cylinder Head	19-26	14-19
Vacuum Pump to Mounting Plate	19-26	14-19
Valve Cover Bolt	8	6
Valve Cover Bolt — Step 2	8	6
Valve Lever Post Bolt	27	20
Water Housing Outlet (Thermostat) to Crankcase	27	20
Water Pump to Front Cover	19 ^f	14
Water Pump Pulley	b	—

a Apply Threadlock and Sealer EOAZ-19554-AA or equivalent to all threads prior to assembly.

b See Standard Torque Chart.

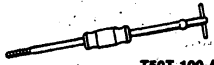

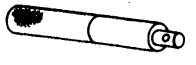

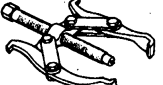


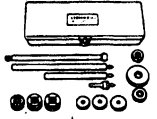


c 1/2 turn after gasket contacts sealing surface.

d Tighten to 47 N-m (35 ft-lb), then tighten again to 47 N-m (35 ft-lb) in sequence. Apply anti-seize compound prior to installation.

e 1-1/4 to 2 turns after gasket contacts sealing surface — oiled gasket.

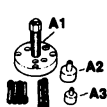
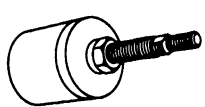
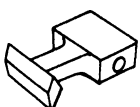

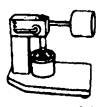

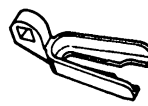
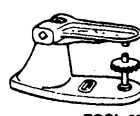


f RTV Sealer required.

SPECIAL SERVICE TOOLS/EQUIPMENT



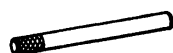

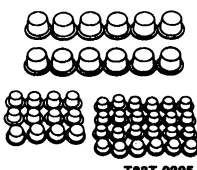
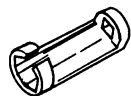



Tool Number/ Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T59L-100-B Impact Slide Hammer	 T59L-100-B
T80T-4000-W Driver Handle	 T80T-4000-W
TOOL-4201-C Dial Indicator w/ Bracketry	 TOOL-4201-C
T77F-4220-B1 Gear Puller	 T77F-4220-B1
T83T-6000-D6.9 6.9L / 7.3L Essential Service Tool Kit	 T83T-6000-D6.9
T70P-6000 Engine Lifting Brackets	 T70P-6000
T65L-6250-A Camshaft Bearing Set	 T65L-6250-A
T83T-6312-A Fan Clutch Pulley Holder	 T83T-6312-A
T83T-6312-B Fan Clutch Nut Wrench	 T83T-6312-B

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT (Continued)

Tool Number/ Description	Illustration
T83T-6316-A Crank / Cam Gear and Damper Remover	 T83T-6316-A
T83T-6316-B Crank / Cam Gear and Damper Replacer	 T83T-6316-B
T74P-6375-A Flywheel Holding Tool	 T74P-6375-A
T83T-6500-A Tappet Bleed-Down Wrench	 T83T-6500-A
TOOL-8500-E Hydraulic Tappet Leakdown Tester	 TOOL-8500-E
TOOL-8505-F Valve Stem Clearance Tool	 TOOL-8505-E
T83T-6513-A Valve Spring Compressor	 T83T-6513-A
TOOL-6513-DD Valve / Clutch Spring Tester	 TOOL-6513-DD
T83T-6571-A Valve Stem Seal Replacer	 T83T-6571-A
T83T-6700-A Front Crank Seal Replacer	 T83T-6700-A

(Continued)

Tool Number/ Description	Illustration
T83T-6701-A Rear Crankshaft Seal Replacer	 T83T-6701-A
T83T-6701-B Rear Crankshaft Seal Pilot	 T83T-6701-B
T86T-9000-B Injection Pump Mounting Wrench	 T86T-9000-B
T83T-9000-C Injection Pump Rotating Tool	 T83T-9000-C
T83T-9395-A Fuel System Protection Cap Set	 T83T-9395-A
T83T-9396-A Fuel Line Nut Wrench	 T83T-9396-A
T83T-9424-A Intake Manifold Cover	 T83T-9424-A
T83T-9527-A Nozzle Seat Cleaner	 T83T-9527-A
T71P-19703-C O-Ring Tool	 T71P-19703-C

Tool Number	Description
D82L-800-B	Hammer
D78P-4201-F	Dial Indicator Bracketry
D78P-4201-G	Dial Indicator — 1-Inch Travel
D81L-4201-A	Feeler Gauge
D81L-6002-B	Plastigage
D81L-6002-C	Piston Ring Compressor
D83T-6002-A	Glow Plug Socket

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT (Continued)

Tool Number	Description
D83L-4201-A	Straight Edge
D83T-9000-E	Throttle Control
D83T-6015-B	Expansion Plug Replacer
D83T-6084-A	Exhaust Valve Seat Remover/Replacer
D83T-6134-B	Cooling Jet Tube Target
D83T-6136-A	Connecting Rod Installation Guides

ROTUNDA EQUIPMENT

Tool Number	Description
014-00036	Universal Load Positioning Sling
014-00300	Injection Nozzle Tester

(Continued)

ROTUNDA EQUIPMENT (Cont'd)

Tool Number	Description
014-00301	Injection Nozzle Cleaning Kit
014-00306	Engine Stand Mounting Adapter
014-00312	Engine Lifting Bracket
014-00701	Compression Tester
014-00702	Pressure Test Kit
014-00726	Oil Cooler Internal Leakage Tester
112-00001	Oil Leak Detector

SECTION 03-03 Engine Cooling

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	03-03-1	REMOVAL AND INSTALLATION	
DESCRIPTION	03-03-1	Thermostat.....	03-03-1
		SPECIFICATIONS	03-03-2

VEHICLE APPLICATION

F-250-350 and F-Super Duty Vehicles with 7.3L Indirect Injection (IDI) Turbo Diesel Engines

DESCRIPTION

For procedures not unique to the 7.3L IDI turbo diesel engine refer to the following pages in Section 03-03 in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual:

SUBJECT	PAGE
CLEANING AND INSPECTION	
Cleaning Cooling System	03-03-32
Heater Core Back-Flushing	03-03-33
Radiator Coolant Level Check.....	03-03-32
Radiator Pressure Cap.....	03-03-35
DESCRIPTION AND OPERATION	
Coolant Recovery System.....	03-03-1
Draining, Filling and Bleeding the Cooling System.....	03-03-6
Radiator.....	03-03-3
DIAGNOSIS AND TESTING	

(Continued)

SUBJECT	PAGE
Cooling System Pressure Test	03-03-7
Diagnosis Guides.....	03-03-11
Leak Test.....	03-03-10
Radiator Cap Pressure Test.....	03-03-9
Thermostat Test.....	03-03-10
Visual Inspection.....	03-03-13
REMOVAL AND INSTALLATION	
Coolant Recovery Bottle	03-03-16
Radiator and Fan Shroud.....	03-03-17
Thermostat	03-03-13
SERVICE PROCEDURES	
Aluminum Crossflow Radiators.....	03-03-40
Copper / Brass Radiators	03-03-36
Radiator Core Service.....	03-03-46
Threaded Radiator Draincock	03-03-39
SPECIAL SERVICE TOOLS / EQUIPMENT.....	03-03-55
SPECIFICATIONS	03-03-53
VEHICLE APPLICATION	03-03-1

REMOVAL AND INSTALLATION

Thermostat

Do not attempt to service the thermostat. It should be replaced if it is not operating properly.

Check the thermostat before installing it, following the Thermostat Test procedures.

7.3L IDI Turbo Diesel V8 Engine

Removal

1. Drain the radiator so that the coolant level is below the thermostat.
2. Remove accessory drive belt.
3. Remove alternator.
4. Loosen the radiator upper hose clamp at the water outlet housing.
5. Remove the radiator upper hose from the water outlet housing.

6. Remove the water outlet housing attaching bolts.
7. Remove the water outlet housing, thermostat and gasket.

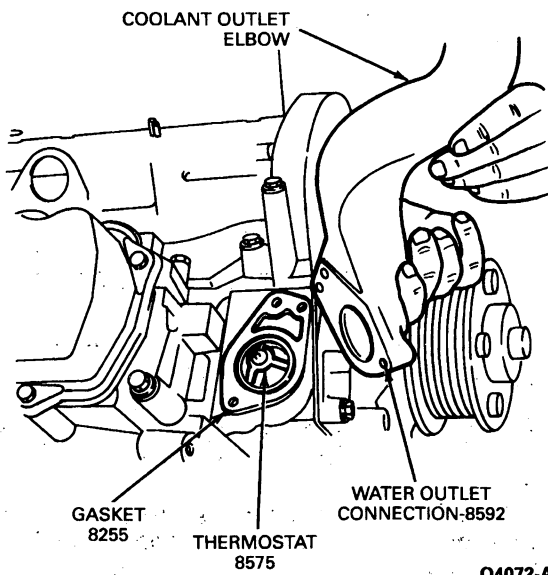
Installation

1. Clean the water outlet housing gasket surfaces. Coat a new water outlet housing gasket with Perfect Seal Sealing Compound B5A-19554-A or D7AZ-19554-BA (ESR-M18P2-A or ESE-M4G115-A) or equivalent.
2. Install the thermostat in the crankcase counterbore with the copper pellet or element toward the engine and the thermostat flange positioned in the recess. If the thermostat is improperly installed, it will cause a retarded flow of coolant.
3. Position the water outlet housing gasket on the crankcase flange.

REMOVAL AND INSTALLATION (Continued)

4. Install the water outlet housing.
 5. Install and tighten the attaching bolts. Refer to Specifications.
 6. Install the radiator upper hose to the water outlet housing and tighten hose clamp.
- WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.**
7. Install alternator.
 8. Install accessory drive belt.
 9. Fill and bleed the cooling system as outlined.
 10. Operate the engine until normal operating temperature is reached; then check the coolant level and check for leaks.

Thermostat Installation, 7.3L IDI Turbo Diesel



SPECIFICATIONS

Description	N-m	Lb-Ft
Thermostat Housing, 7.3L IDI Turbo Diesel	27	20

SECTION 03-12 Air Intake

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	03-12-1	REMOVAL AND INSTALLATION	
DESCRIPTION AND OPERATION		Air Cleaner, 7.3L IDI Turbo Diesel Engine.....	03-12-1
Air Cleaner Element.....	03-12-1	SPECIFICATIONS	03-12-2

VEHICLE APPLICATION

All Vehicles Equipped with 7.3L Indirect Injection (IDI)
Turbo Diesel Engine

DESCRIPTION AND OPERATION

Air Cleaner Element

The air cleaner element is a pleated paper panel type and features expanded foam filter media attached to the bottom of the paper. This filter has specifically been designed to provide adequate filter life.

NOTE: Non-Ford Motorcraft replacement filters may result in significantly shortened filter life and dirt ingestion.

REMOVAL AND INSTALLATION

Air Cleaner, 7.3L IDI Turbo Diesel Engine

Removal

1. Loosen hose clamp retaining upper air cleaner housing to turbocharger inlet.
2. Loosen hose clamp retaining CDR tube to upper air cleaner housing.
3. Remove nuts retaining upper air cleaner housing to lower air cleaner housing. Rotate upper housing up and pull off of turbocharger inlet.
4. Before installing a new element in the air cleaner, check the following items:
 - a. Gasket surfaces should be clean and undamaged.
 - b. Inlet tube should be clean and undamaged.
 - c. Element should be dry and free of holes, ruptures, damaged gaskets or dents in end covers and liners.
 - d. Inspect water drain hole for possible restrictions.

Installation

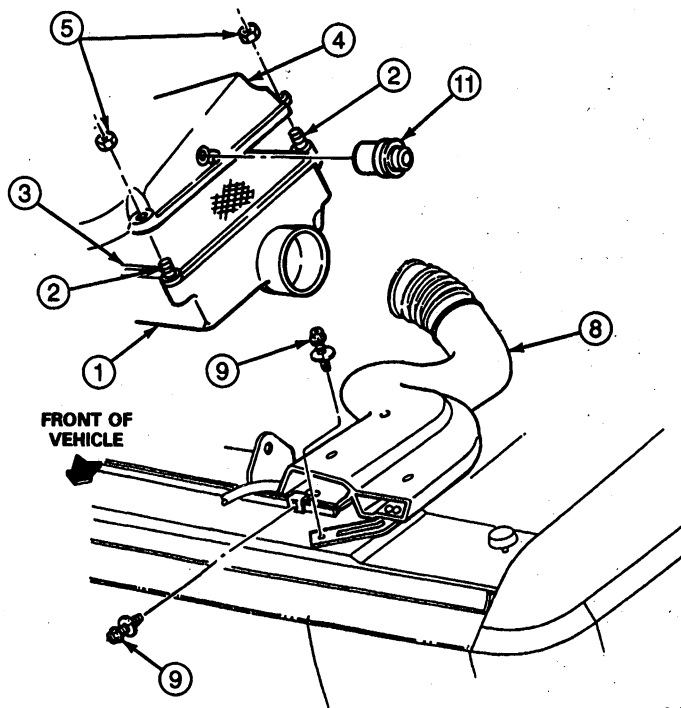
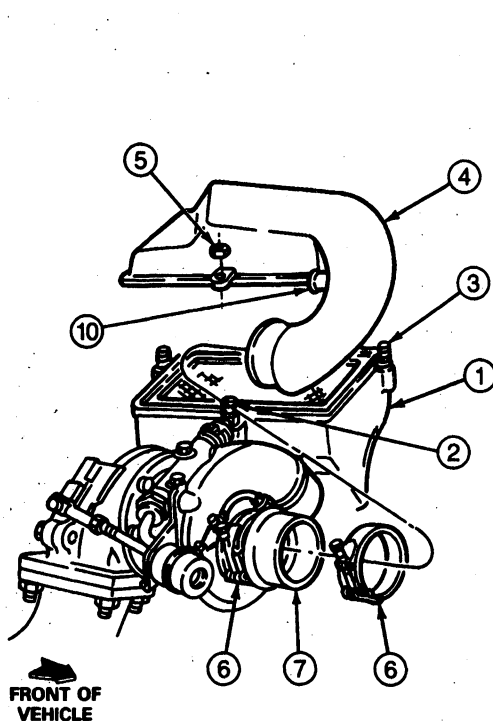
After the air cleaner housing, element, and other parts are found to be in good condition, reassemble the parts.

CAUTION: A special filtering element is required on IDI turbo engines. Use only a specific Ford replacement. Use of other elements could result in serious engine damage. Do not attempt to clean element. Discard and replace.

1. Install the element.
2. Install the cover. Make sure seal is in place. Replace if worn or damaged.
3. Install upper air cleaner housing to turbocharger inlet. Then rotate upper housing down onto lower housing.
4. Install CDR tube and tighten clamp. Install air cleaner housing nuts and tighten to specifications.

REMOVAL AND INSTALLATION (Continued)

Air Cleaner Installation, F-250, F-350 and F-Super Duty, 7.3L IDI Turbo Diesel Engine



V9195-A

Item	Part Number	Description
1	9600	Air Cleaner Bottom Housing
2	—	Stud
3	9601	Air Filter Element
4	9661	Air Cleaner Cover
5	—	Nut

(Continued)

Item	Part Number	Description
6	—	Clamp
7	9C681	Air Cleaner to Turbo Hose
8	—	Duct Tube
9	N805660-S	Rivet
10	—	Clamp
11	9N622	Air Cleaner Restriction Indicator

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N-m	In-Lb
F-Series, 7.3L Diesel Air Cleaner Nut	2-3	18-27

SECTION 03-12B Turbocharger, 7.3L IDI Turbo Diesel Engine

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	03-12B-1	INSPECTION	
DESCRIPTION AND OPERATION	03-12B-1	Bearing Clearance Inspection	03-12B-11
REMOVAL AND INSTALLATION		Turbocharger Boost Functional Check	03-12B-11
Oil Drain Pedestal	03-12B-6	Turbocharger Wastegate Actuator	
Oil Feed Tube	03-12B-5	Assembly	03-12B-12
Turbocharger	03-12B-3	Turbocharger Wastegate Actuator Assembly	
Turbocharger Wastegate Actuator		Functional Check	03-12B-11
Assembly	03-12B-4	Turbocharger Wastegate Valve Assembly	
DISASSEMBLY AND ASSEMBLY		Inspection	03-12B-12
Assembly	03-12B-9	SPECIFICATIONS	03-12B-13
Turbocharger	03-12B-6	SPECIAL SERVICE TOOLS	03-12B-13

VEHICLE APPLICATION

Vehicles Equipped with 7.3L IDI Turbo Diesel Engines

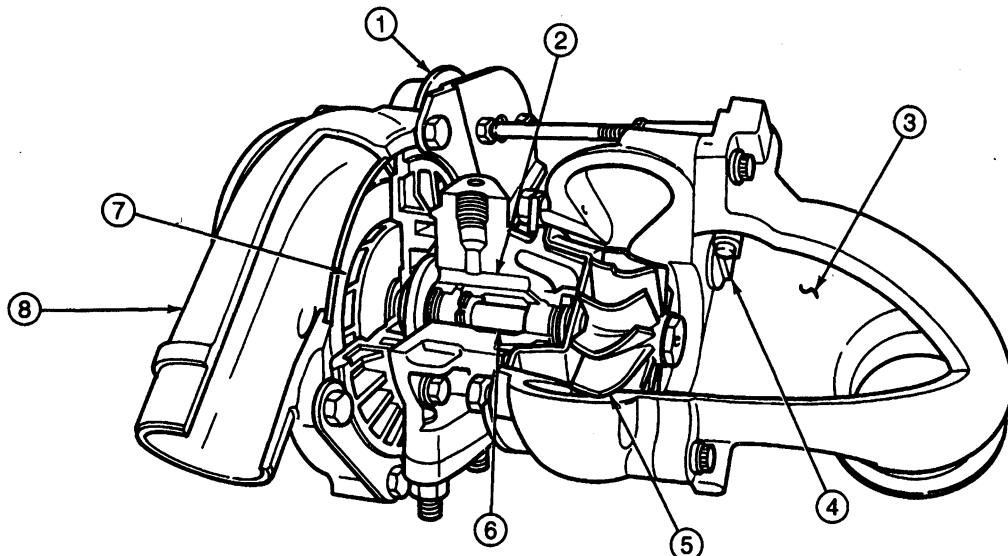
DESCRIPTION AND OPERATION

The Garret T3 turbocharger used on 7.3L IDI Turbo Diesel engines, consists of gas turbine and air compressor wheels mounted on opposite ends of a common shaft. The wheels are enclosed by housings, the shaft by a center housing.

The turbine is a centripetal (from outside to center), radial inflow mechanism consisting of a cast turbine wheel, wheel shroud, and a specially-designed housing that encloses the wheel and directs the flow of gas through the turbine.

The compressor is a centrifugal, radial outflow mechanism consisting of a cast compressor wheel, a backplate assembly, and a specially designed housing that encloses the wheel and directs the flow of air through the compressor.

Garret T3 Turbocharger Cutaway View



A20420-A

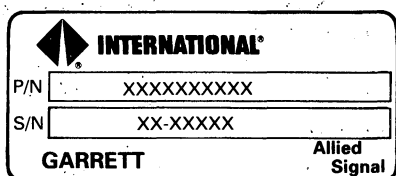
DESCRIPTION AND OPERATION (Continued)

Item	Description
1	Wastegate Actuator
2	Center Housing
3	Wastegate Housing

(Continued)

Item	Description
4	Wastegate
5	Turbine Wheel
6	Common Shaft
7	Compressor Wheel
8	Compressor Outlet Housing

The turbocharged engine can be identified by the turbocharger I.D. plate.



A20421-A

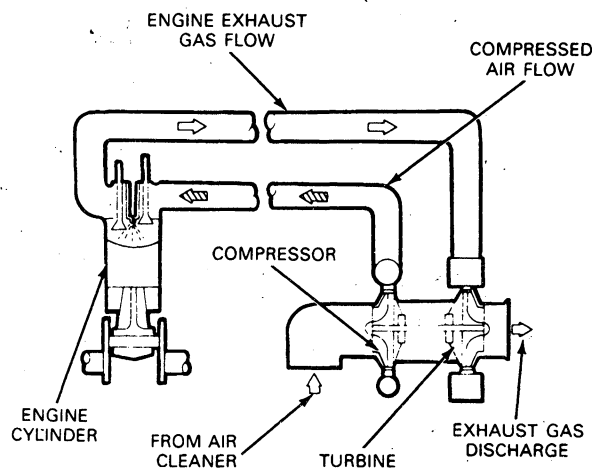
The center housing supports the compressor and turbine wheel shaft in a pair of identical bearings which contain oil holes for directing oil to the bearing bores and shaft journals. Passages drilled in the center housing direct oil supplied by the engine from the inlet port to oil grooves machined in the bearing bores, which align with holes in the bearings.

The Garret T3 turbocharger is equipped with a wastegate. The wastegate opens when the turbocharger produces a predetermined amount of boost pressure. This prevents the turbocharger from supplying too much boost which could cause engine damage.

During operation of a turbocharged engine, exhaust gas from the engine exhaust manifold flows into the turbine. The exhaust gas pressure and the heat energy extracted from the gas cause the turbine wheel to rotate which, in turn, causes the compressor wheel to rotate.

The cooled and expanded exhaust gas leaving the turbine wheel is directed by the turbine housing to engine exhaust system, which expels it to atmosphere.

Rotation of the compressor wheel causes ambient air from the engine air cleaner to be drawn into the compressor housing, where it is compressed and delivered to appropriate ducting which delivers it to the engine intake manifold.

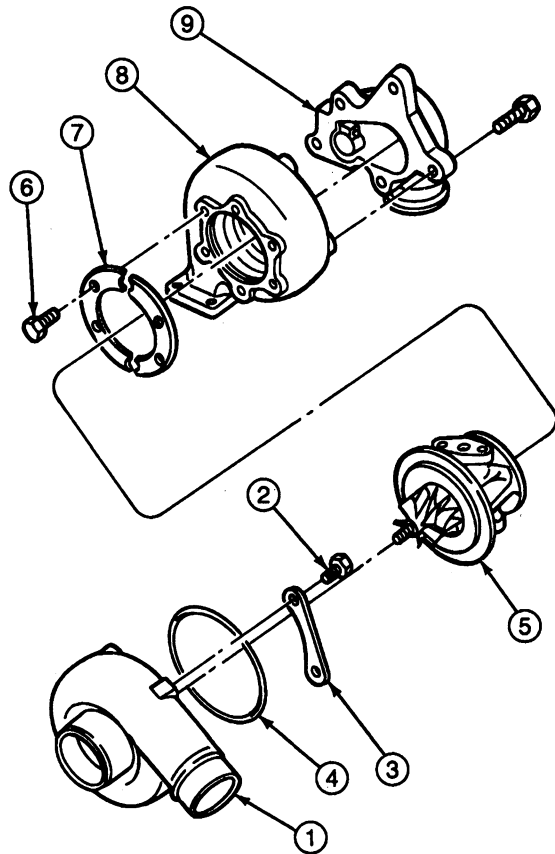


V4308-1A

Split ring seals are installed at each end of the shaft between the bearing and the adjacent turbine or compressor wheel to prevent lubricating oil from entering the turbine and the compressor area.

DESCRIPTION AND OPERATION (Continued)

Garret T3 Turbocharger



A20422-A

Item	Description
1	Compressor Housing
2	Hex Head Setscrew (6)
3	Compressor Housing Clamp (2)
4	Compressor Housing O-Ring
5	Center Section
6	Hex Head Setscrew
7	Turbine Housing Clamp (2)

(Continued)

Item	Description
8	Turbine Housing
9	Wastegate Housing

REMOVAL AND INSTALLATION

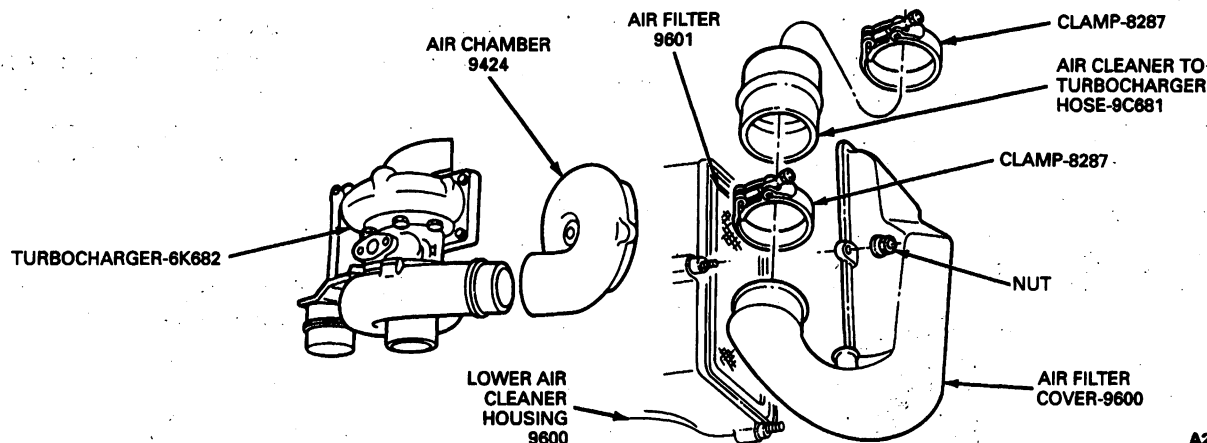
Turbocharger

Removal

1. Disconnect ground cables from both batteries.
2. Raise vehicle.
3. Remove two nuts retaining exhaust crossover pipe to left exhaust manifold.
4. Remove two nuts retaining Y-collector pipe to right exhaust manifold.
5. Remove Y-collector and crossover pipe. Twist crossover pipe back and forth while pulling down.
6. Lower vehicle.
7. Remove air cleaner assembly and air duct to turbocharger.
8. Disconnect oil pressure sender wire.
9. Remove turbocharger oil supply line.
10. Loosen marman clamp retaining exhaust down pipe to wastegate housing.
11. Remove two bolts retaining oil drain pedestal to rear intake manifold.
12. Remove air chamber hold-down bolt from intake manifold.
13. Pull turbocharger assembly up and out of intake manifold valley pan grommet. Position turbocharger towards heater box, rotated slightly counterclockwise.
14. Remove air chamber from turbocharger.
15. Remove two nuts retaining oil drain pedestal to turbocharger center housing.
16. Remove oil drain pedestal and set in intake manifold valley.

REMOVAL AND INSTALLATION (Continued)

17. Remove turbocharger assembly.



A20423-A

Installation

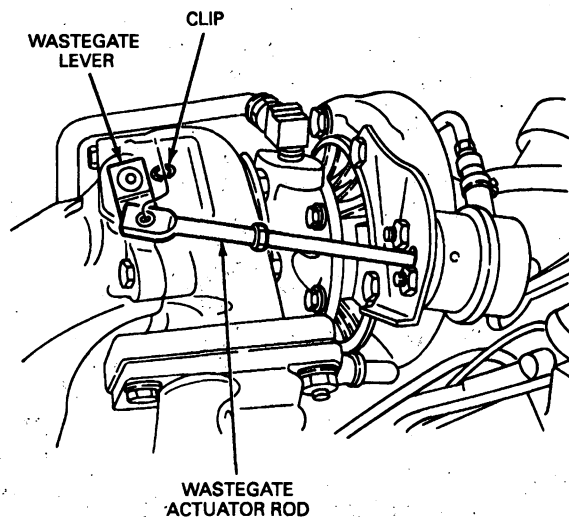
1. Install turbocharger assembly.
2. Loosely install marman clamp on wastegate exhaust outlet.
3. Install oil drain pedestal onto turbocharger mounting studs. Tighten retaining nuts to 40 N-m (30 ft-lb).
4. Install air chamber on turbocharger compressor housing.
5. Lift and rotate turbocharger to align oil drain pedestal with valley pan grommet. Push turbocharger assembly down to seat oil drain pedestal in grommet.
6. Loosely install two bolts retaining drain pedestal to intake manifold.
7. Raise vehicle.
8. Install exhaust crossover pipe to left exhaust manifold. Loosely install two retaining nuts.
9. Install Y-collector pipe into turbocharger exhaust inlet housing by tapping Y-collector flange with a long drift punch.
10. Install two bolts retaining Y-collector pipe to right exhaust manifold. Tighten bolts to 34-46 N-m (25-36 ft-lb).
11. Tighten two nuts retaining exhaust crossover pipe to left exhaust manifold to 34-46 N-m (25-36 ft-lb).
12. Lower vehicle.
13. Tighten oil drain pedestal retaining bolts to 19 N-m (14 ft-lb).
14. Install turbocharger oil supply line.
15. Connect oil pressure sender wire.
16. Install air cleaner assembly and air intake ducts.

17. Connect both battery ground cables.
18. Start engine. Inspect for oil and exhaust leaks.

Turbocharger Wastegate Actuator Assembly Removal and Installation

CAUTION: Be careful not to bend the control lever.

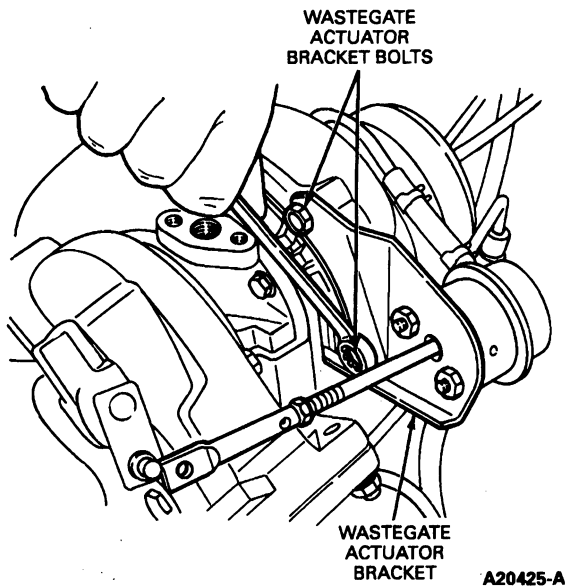
1. Remove the retaining clip from the wastegate control lever.



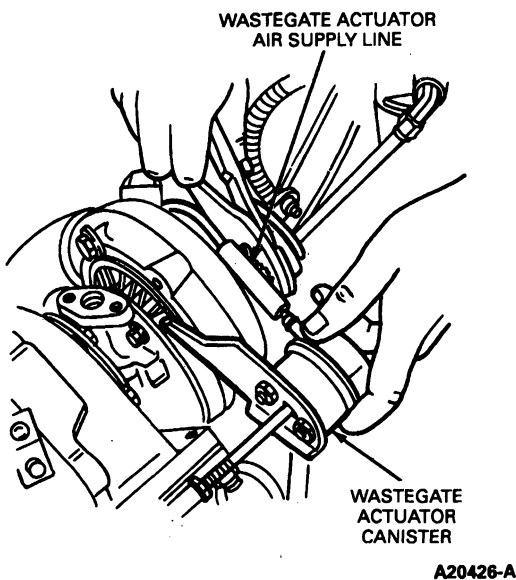
A20424-A

REMOVAL AND INSTALLATION (Continued)

2. Remove the two bolts retaining the wastegate actuator assembly.



3. Remove the wastegate actuator assembly from the turbocharger.
4. Disconnect the manifold pressure air supply hose from the wastegate actuator canister.

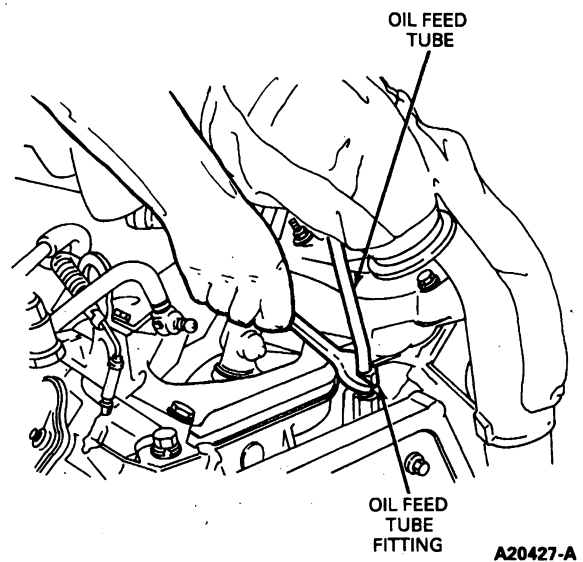
**Installation**

1. Connect air supply line to new wastegate actuator canister.
2. Install new wastegate actuator assembly to turbocharger and tighten retaining bolts to 31 N·m (23 ft-lb).
3. Adjust actuator rod to install on wastegate lever and lock into position by tightening rod nut.

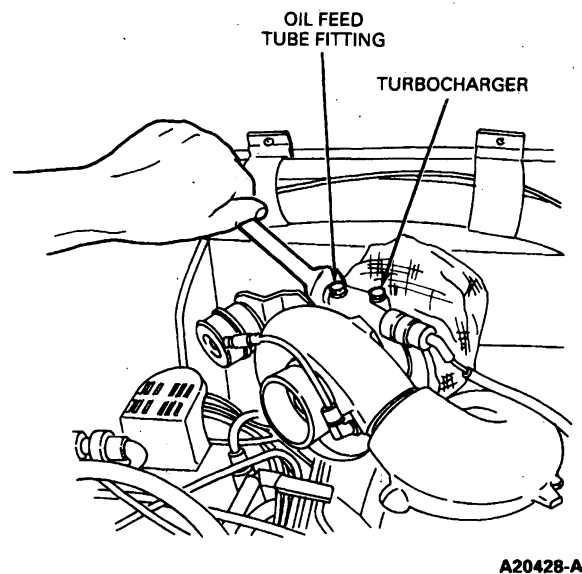
4. Remove service gauge clamp from actuator rod after actuator rod is installed.
5. Install retaining clip to wastegate lever.
6. Verify wastegate actuator is functioning correctly as outlined in this section.

Oil Feed Tube**Removal**

1. Remove air cleaner assembly.
2. Remove oil feed tube nut at rear of engine.



3. Remove oil feed tube nut at turbocharger center section.



REMOVAL AND INSTALLATION (Continued)

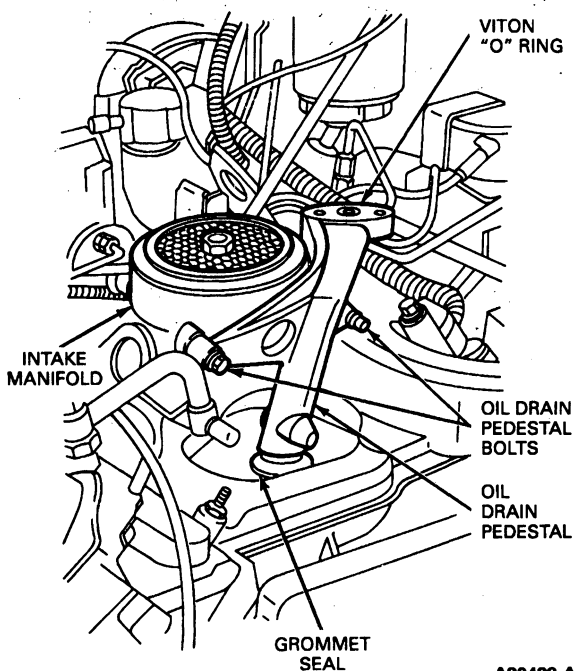
4. Remove oil feed tube.

Installation

1. Follow the removal procedure in reverse order for installation.

Oil Drain Pedestal**Removal**

1. Remove turbocharger assembly as outlined in this section.
2. Remove oil drain pedestal.



A20423-A

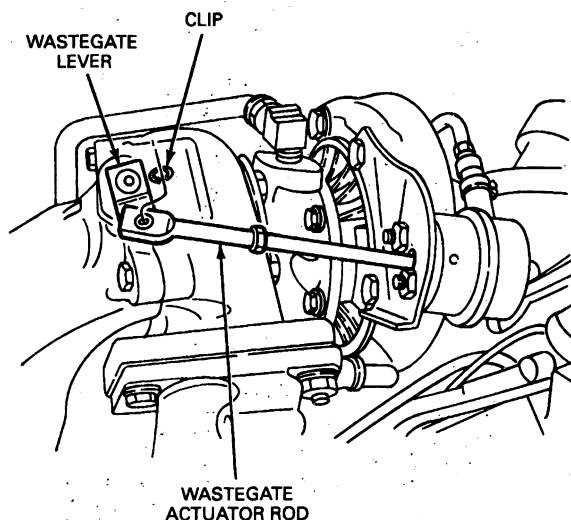
Installation

1. Follow the removal procedure in reverse order for installation.

DISASSEMBLY AND ASSEMBLY**Turbocharger****Disassembly**

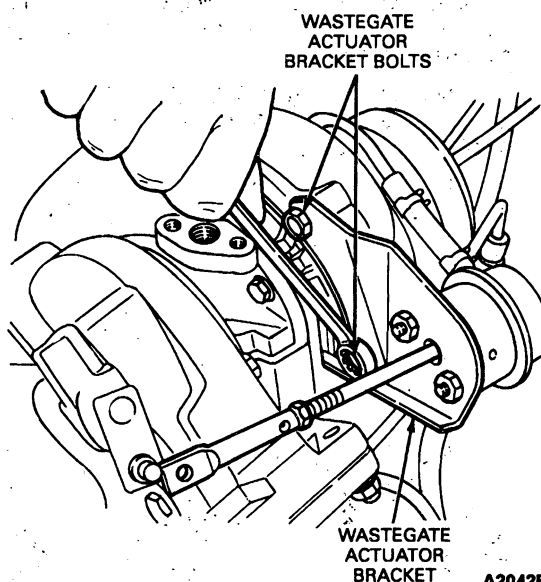
CAUTION: Be careful not to bend the wastegate control lever.

1. Remove the retaining clip from the wastegate control lever.



A20424-A

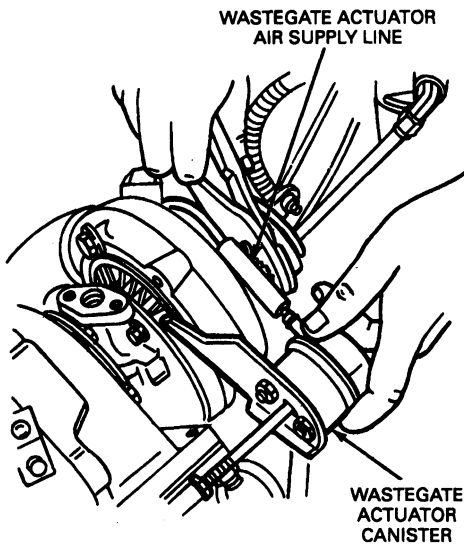
2. Remove the two bolts retaining the wastegate actuator assembly.



A20425-A

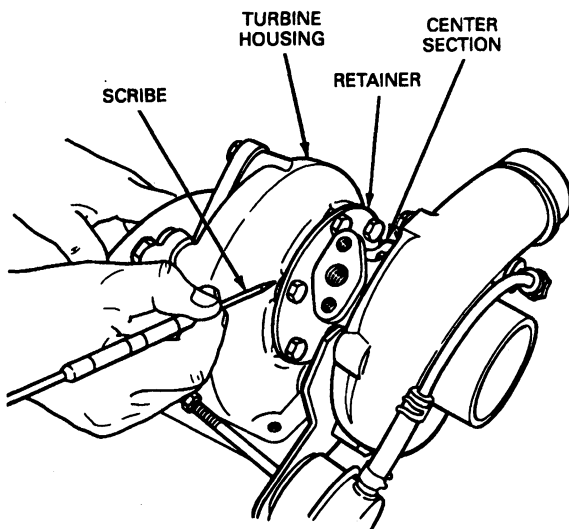
DISASSEMBLY AND ASSEMBLY (Continued)

3. Disconnect the manifold pressure air supply hose from the wastegate actuator canister.



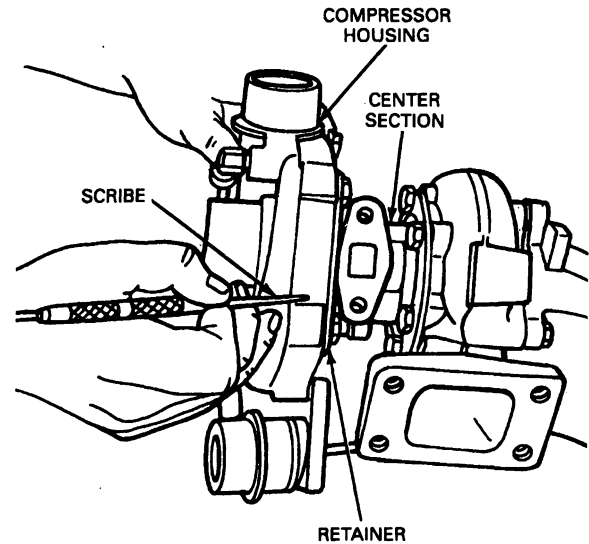
A20426-A

4. Remove the wastegate actuator assembly from the turbocharger.
 5. Remove the four nuts retaining the turbocharger exhaust inlet pipe and remove the turbocharger exhaust inlet pipe.
 6. Remove the five bolts retaining the wastegate housing to the turbine housing and remove the wastegate housing.
 7. Scribe the turbine housing in reference to the center section to properly index the housing during reassembly.



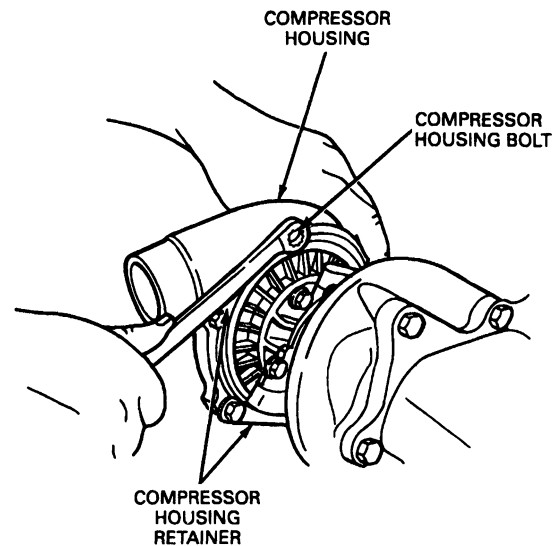
A20430-A

8. Scribe the compressor housing in reference to the center section to properly index the housing during reassembly.



A20431-A

9. Remove the remaining four compressor housing bolts and remove the two retaining clamps.

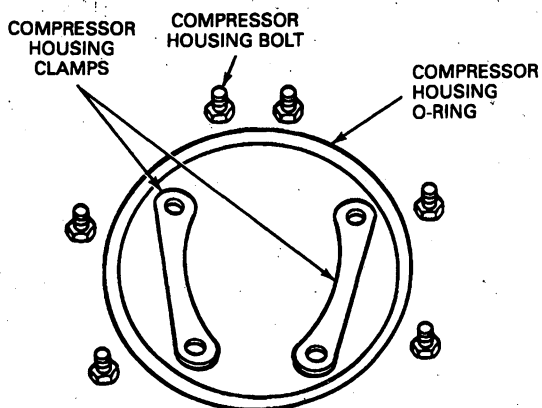
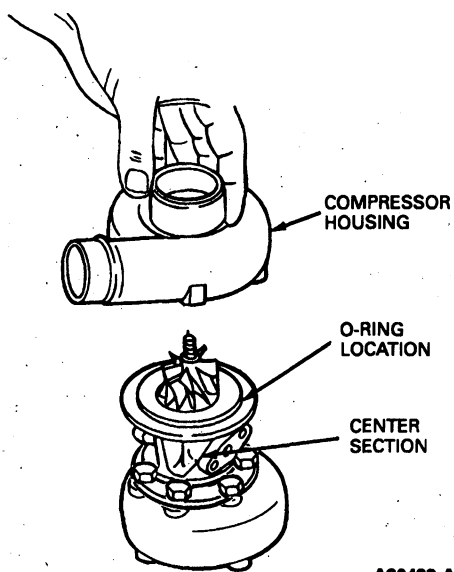


A20432-A

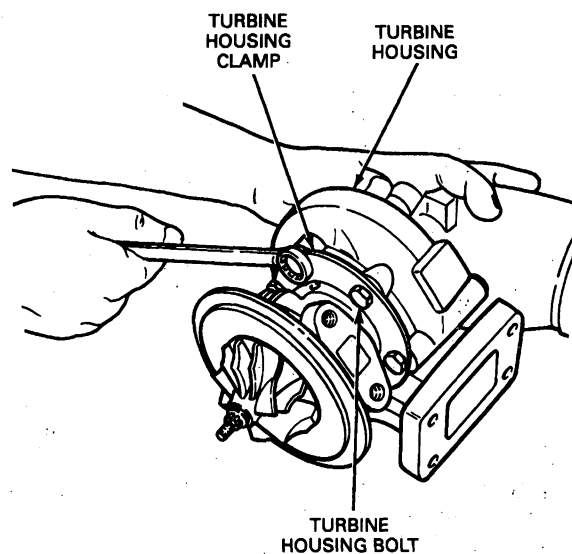
WARNING: TURBINE BLADES ARE VERY SHARP. WEAR GLOVES OR USE A SHOP RAG WHEN HANDLING TURBINE TO AVOID INJURY.

DISASSEMBLY AND ASSEMBLY (Continued)

10. Remove the compressor housing and o-ring from the center section.

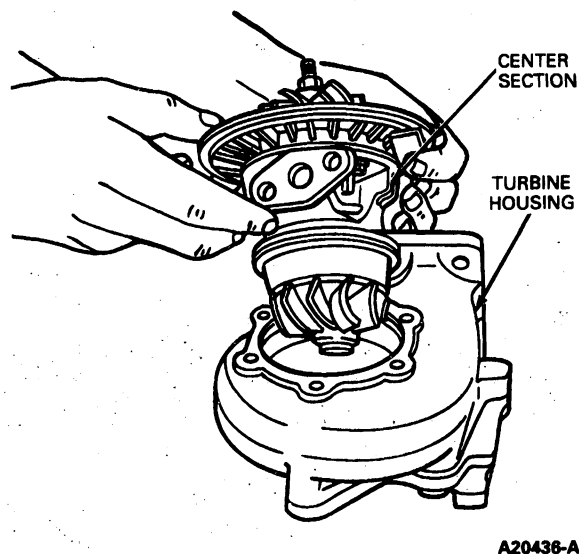


11. Remove the six turbine housing bolts and remove the two retaining clamps.

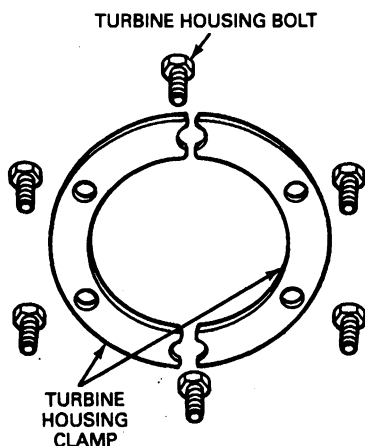


WARNING: TURBINE BLADES ARE VERY SHARP. WEAR GLOVES OR USE A SHOP RAG WHEN HANDLING TURBINE TO AVOID INJURY.

12. Remove the turbine housing from the center section.



DISASSEMBLY AND ASSEMBLY (Continued)



A20437-A

13. Inspect the housings for wheel rub and the turbine and compressor wheel for damage.

Cleaning

CAUTION: Do not use a wire brush on the compressor wheel.

1. Use a stiff-bristle nylon brush and solvent to clean parts.
2. Remove any carbon build-up from the housing with a scraper and a medium grit emery cloth.
3. After cleaning all parts in solvent, use compressed air to dry.

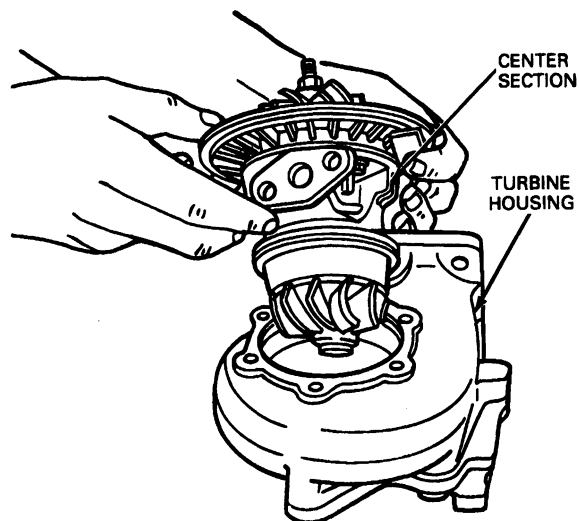
Inspection

1. Inspect turbine shaft for excessive axial or radial play.
2. Inspect compressor and turbine housings for wheel rub.
3. Inspect compressor and turbine wheels for excessive wear or damage.

Assembly

NOTE: Make sure center section is properly seated in the housing and the scribed index marks are aligned.

1. Install the center section into the turbine housing.



A20436-A

NOTE: Apply anti-seize compound to threads of bolts.

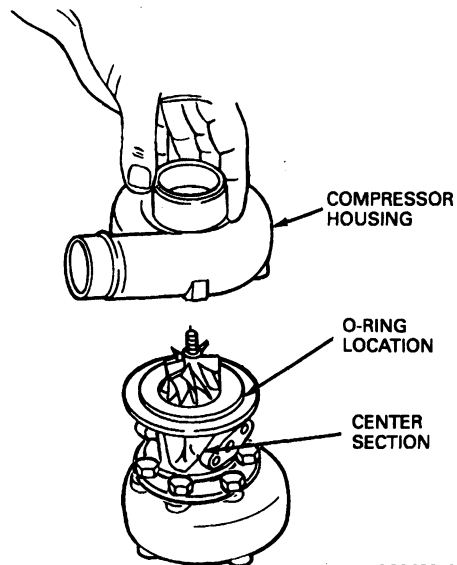
2. Install the two retaining clamps and the six turbine housing bolts. Tighten to 35 N·m (26 ft-lb).

NOTE: Make sure o-ring is properly seated and the scribed index marks on the housing and center section are aligned.

3. Install the compressor housing o-ring and the compressor housing to the center section.

NOTE: Apply anti-seize compound to threads of bolts.

4. Install the two retaining clamps and four compressor housing bolts, tighten bolts to 35 N·m (26 ft-lb).

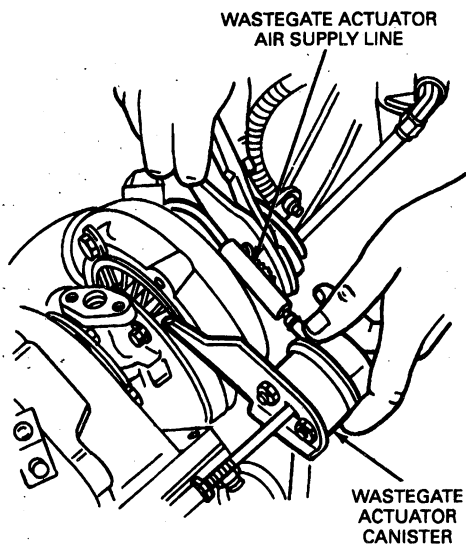


A20433-A

DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: Apply anti-seize compound to threads of bolts.

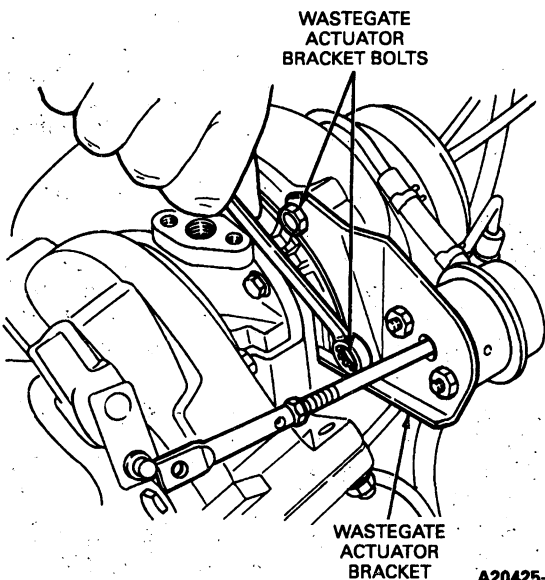
5. Install the wastegate housing and the five bolts retaining the wastegate housing to the turbine housing, tighten bolts to 35 N·m (26 ft-lb).
6. Install the wastegate actuator assembly to the turbocharger, place actuator rod on wastegate lever.
7. Connect the manifold pressure air supply hose to the wastegate actuator canister.



A20426-A

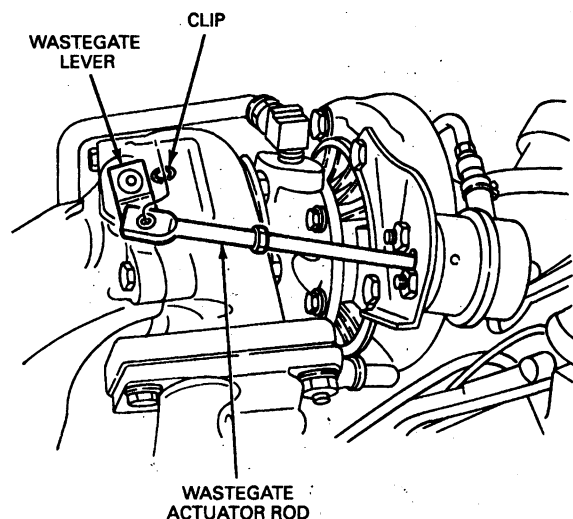
NOTE: Apply anti-seize compound to threads of bolts.

8. Install the two bolts retaining the wastegate actuator assembly to the compressor housing, tighten bolts to 31 N·m (23 ft-lb).

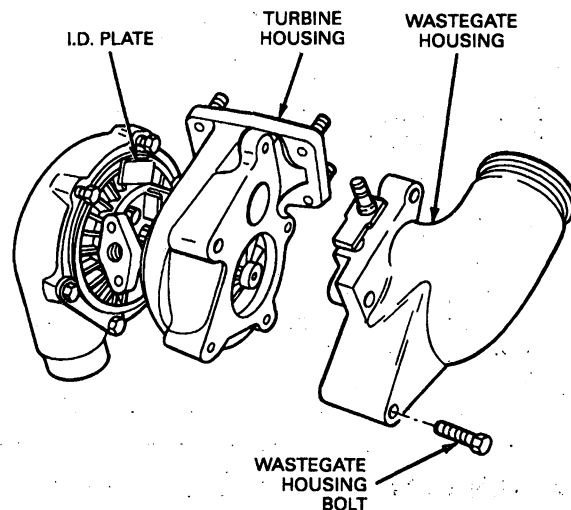


A20425-A

9. Install the retaining clip to the wastegate control lever.



A20424-A

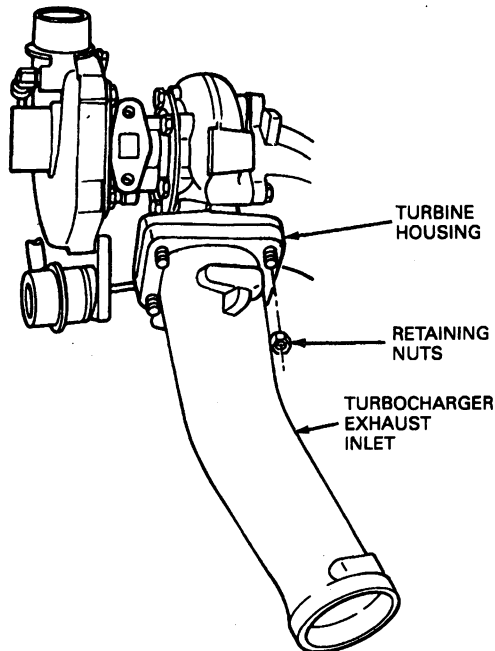


A20438-A

NOTE: Apply Anti-Seize compound to threads of studs.

DISASSEMBLY AND ASSEMBLY (Continued)

10. Install the turbocharger exhaust inlet pipe and the four nuts retaining the turbocharger exhaust inlet pipe. Tighten nuts to 35 N·m (26 ft-lb).



A20439-A

11. Rotate compressor wheel and make sure that the wheels do not rub on the housings.

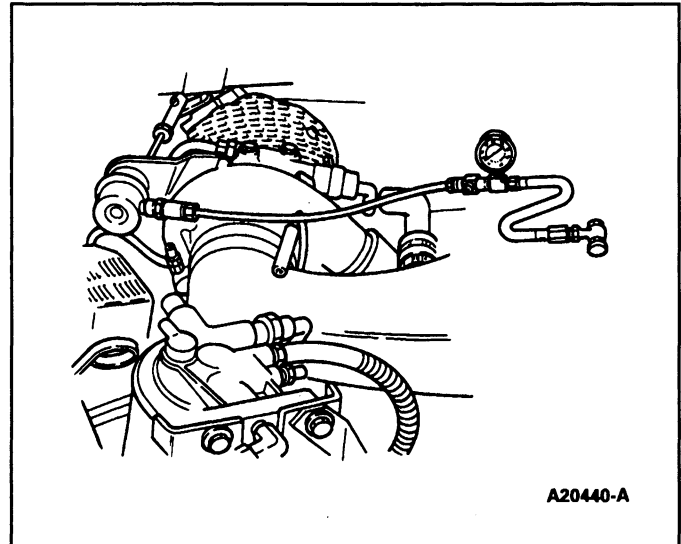
INSPECTION

For turbocharger diagnostic and testing procedures other than those covered below, refer to Section 20A in the Powertrain Control/Emission Diagnosis Manual.¹

Turbocharger Wastegate Actuator Assembly Functional Check

1. Connect hand pump with 0-30 psi gauge to wastegate actuator diaphragm.
2. Apply 15 psi to actuator diaphragm. Actuator rod movement should start.
3. Apply 22 psi to actuator diaphragm. Actuator rod should be at full travel.
4. At 22 psi there should be no drop in pressure for a minimum of 30 seconds. If pressure drops, wastegate actuator diaphragm is defective. Replace assembly.

¹ Can be purchased as a separate item.



A20440-A

Turbocharger Boost Functional Check

1. Remove air cleaner assembly.
2. Remove plug in air chamber test port.
3. Connect 0-15 psi gauge bar to test port of air chamber.
4. Install air cleaner assembly.
5. On vehicles equipped with automatic transmissions, perform a converter stall test (1680-2100 rpm). A minimum of 5 psi should be observed.
6. On vehicles equipped with manual transmissions, perform a load test. While driving the vehicle in second gear accelerate from 1200 rpm to 2800 rpm. A minimum of 5 psi should be observed.

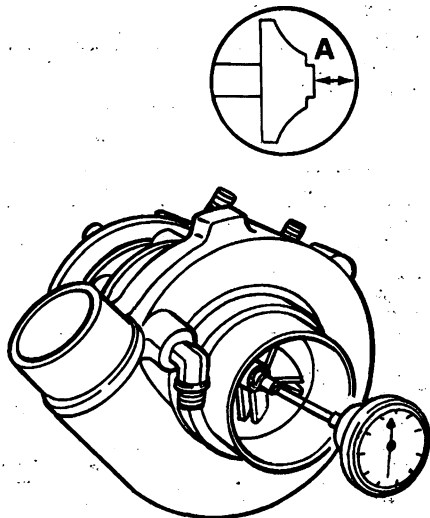
Bearing Clearance Inspection

When there is reason to suspect that the turbocharger bearings are sufficiently worn to permit either the compressor or turbine wheel to rub the housing (when there is an audible indication of rubbing), it is recommended that the following bearing clearance inspection procedures be performed.

1. Remove the turbocharger as outlined in this section.
 - Visually inspect the entire inlet and outlet surfaces for signs of wheel-to-housing rub with a powerful light. If scratching has occurred, the turbocharger center section should be replaced.
 - If scratches or damage to housing are severe, replace damaged housing.
 - Refer to Removal and Installation procedure in this section.
 - If there is no sign of wheel-to-housing rubbing/interference, proceed to Step 2.

INSPECTION (Continued)

2. Measure the shaft end play using Dial Indicator D78P-4201-B or equivalent. End play is represented by dimension A in the illustration.

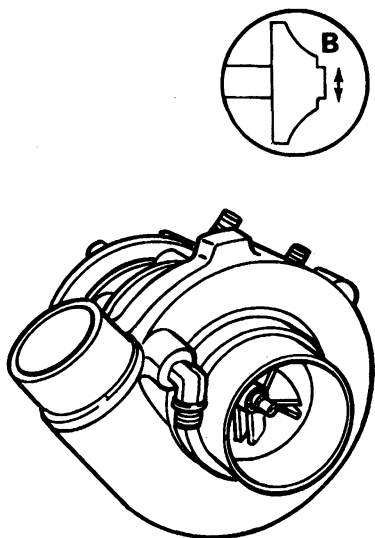


A20441-A

END PLAY

mm		In	
Min.	Max.	Min.	Max.
0.03	0.10	0.001	0.004

3. Inspect radial clearance of the shaft. Pull up on both ends of the compressor shaft and rotate. The turbocharger must be removed for replacement or rebuilt if wheel rub occurs.

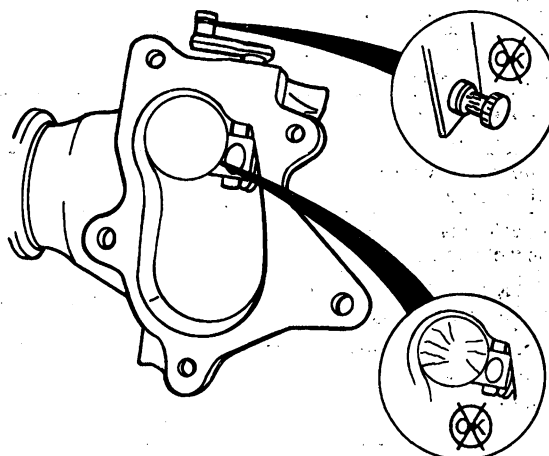


A20442-A

Turbocharger Wastegate Valve Assembly Inspection

1. Inspect the lever pin. Replace the wastegate housing assembly if worn excessively.
2. Inspect the valve and valve seat for cracks or erosion.

Replace the wastegate housing assembly if worn excessively.

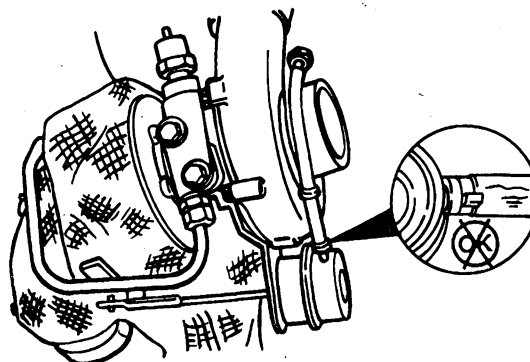


A20443-A

3. Actuate the lever by hand to be sure that the shaft rotates freely and is not seized. Check for excessive movement between the shaft and bushing. Replace the wastegate housing assembly if the shaft and bushing are damaged or seized.

Turbocharger Wastegate Actuator Assembly

1. Visually inspect the wastegate actuator hose for cracks or holes. Replace the hose if damaged.



A20444-A

INSPECTION (Continued)

2. Visually inspect the wastegate mounting bracket, actuator rod and lever for damage. A bent wastegate mounting bracket, actuator rod, or lever can cause improper operation.

- If the wastegate mounting bracket, actuator rod or lever is bent, it must be replaced.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	Lb-Ft
Turbocharger Oil Drain Pedestal to Intake Manifold Bolt	19	14
Turbocharger Oil Drain Pedestal to Turbocharger Nut	40	30
Turbocharger Oil Feed Line to Turbocharger	35	26
Turbocharger Oil Feed Line Connector to Engine Block	35	26
Wastegate Actuator Assembly to Compressor Housing Bolts	31	23
Wastegate Housing Assembly to Turbine Housing Bolt	35	26

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Turbine Housing to Center Section Bolt	35	26
Compressor Housing to Center Section Bolt	35	26
Turbocharger Exhaust Inlet Pipe to Turbine Housing Nut	35	26

TURBOCHARGER BEARING CLEARANCE

mm		In	
Min.	Max.	Min.	Max.
END PLAY			
0.030	0.10	0.001	0.004

SPECIAL SERVICE TOOLS

Tool Number	Description
D78P-4201-B	Dial Indicator / Magnetic Base

GROUP

07

TRANSMISSION

SECTION TITLE	PAGE	SECTION TITLE	PAGE
TRANSMISSION, AUTOMATIC E4OD	07-01A-1	TRANSMISSION, MODEL S5-42 ZF	07-03C-1

SECTION 07-01A Transmission, Automatic, E4OD

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	07-01A-1	REMOVAL AND INSTALLATION	
DESCRIPTION	07-01A-1	Transmission	07-01A-2

VEHICLE APPLICATION

All F-Series Vehicles Equipped with 7.3L Indirect Injection (IDI) Turbo Diesel Engines

DESCRIPTION

For procedures not unique to the 7.3L IDI turbo diesel engine refer to the following pages in Section 07-01A in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super-Duty Powertrain / Drivetrain Manual:

SUBJECT	PAGE
CLEANING AND INSPECTION	
Case Assembly	07-01A-194
Converter and Transmission Cooler	07-01A-194
Electrical Connectors and Solenoid Body	07-01A-193
Forward, Direct, Intermediate, Overdrive, Coast and Reverse Clutches	07-01A-193
Oil Cooler Line Leakage	07-01A-194
One-Way Clutches	07-01A-193
Output Shaft	07-01A-193
Planet Assemblies	07-01A-194
Thrust Bearings	07-01A-194
Transmission	07-01A-193
Transmission Fluid Drain and Refill	07-01A-194
Valve Bodies	07-01A-193
DESCRIPTION	
E4OD Automatic Transmission	07-01A-1

(Continued)

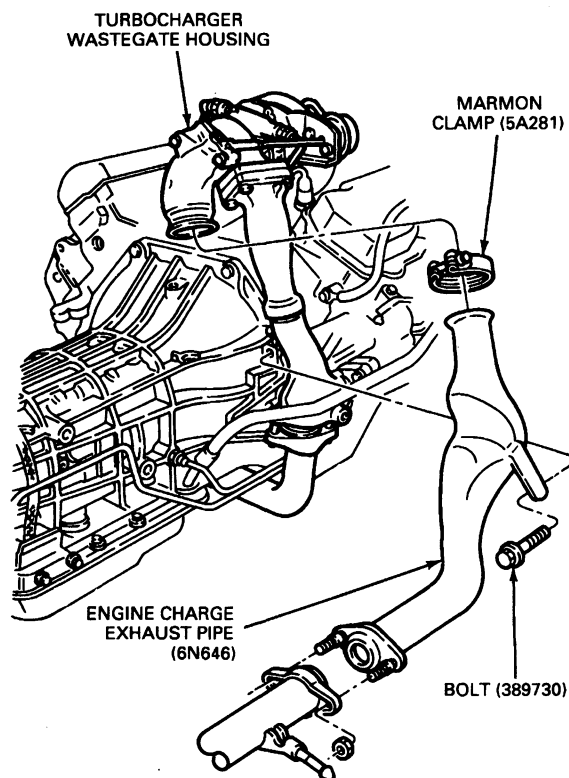
SUBJECT	PAGE
E4OD Sensors and Actuators	07-01A-7
Shift Solenoid Failure Modes	07-01A-14
Solenoid Operation	07-01A-14
DIAGNOSIS AND TESTING	
After On-Board Diagnostics	07-01A-65
Air Pressure Checks	07-01A-21
Automatic Transmission	07-01A-17
Checking the Automatic Transmission Fluid Level	07-01A-16
Converter and Fluid Cooler	07-01A-19
Converter Leakage Check	07-01A-18
Drive Cycle Test	07-01A-65
Electrical / Hydraulic / Mechanical / Diagnosis Charts	07-01A-27
Electrical / Hydraulic / Mechanical / Diagnosis Charts	07-01A-28
Fluid Condition Check	07-01A-17
Line Pressure Test	07-01A-19
Pinpoint Tests	07-01A-66
Preliminary Inspection	07-01A-15
Quick Tests	07-01A-63
Stall Speed Test	07-01A-20
Throttle Position (FIPL) Sensor	07-01A-23

(Continued)

DESCRIPTION (Continued)

SUBJECT	PAGE
Torque Converter Clutch Test.....	07-01A-24
Transmission Fluid Cooler Flow Test	07-01A-19
Transmission Solenoids and Sensors	
Resistance Tests	07-01A-71
Transmission Tester 007-00085	
Instructions	07-01A-70
Verification of Condition	07-01A-15
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Extension Housing	07-01A-189
Forward Hub and Ring Gear.....	07-01A-170
Intermediate Brake Drum	07-01A-172
Forward Planet Assembly	07-01A-184
Input Shell	07-01A-185
Pump	07-01A-149
Coast Clutch Cylinder Assembly.....	07-01A-156
Overdrive Ring Gear And Center Shaft	
Assembly.....	07-01A-160
Reverse Clutch Piston.....	07-01A-188
Reverse Planet Assembly	07-01A-186
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Extension Housing Seal and Bushing	07-01A-99
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Valve Bodies and Intermediate Band	
Servo	07-01A-103
SPECIAL SERVICE TOOLS / EQUIPMENT	07-01A-197
SPECIFICATIONS	
Transmission.....	07-01A-195

5. Raise vehicle on a hoist and position suitable safety stands under vehicle.
6. Remove bolt retaining engine charge exhaust pipe to transmission housing.
7. Remove nuts retaining exhaust extension pipe to muffler and pipe assembly.
8. Remove engine charge exhaust pipe and extension pipe.



D11324-A

REMOVAL AND INSTALLATION

Transmission

TOOLS REQUIRED

Description	Tool Number
Torque Converter Handles	T81P-7902-C

Removal

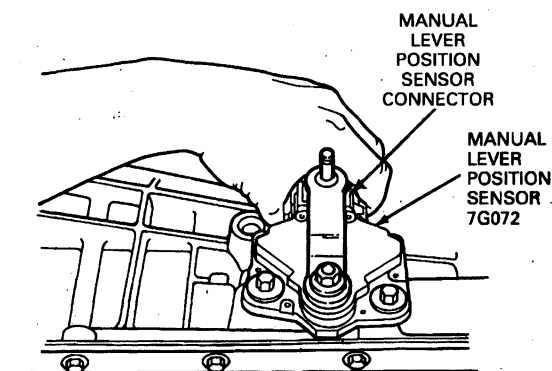
1. Disconnect negative battery cables at the batteries.
2. Loosen marman clamp at wastegate housing exhaust outlet.
3. Remove transmission dipstick.
4. Place transmission selector in NEUTRAL position.

9. Remove skid plate (4x4 vehicles).
10. On 4x4 models only, remove front driveshaft. Refer to Section 05-01 Driveshaft, in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
11. Remove rear driveshaft. Refer to Section 05-01 Driveshaft, in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual. On F-Super Duty vehicles, remove the transmission-mounted parking brake. Refer to Section 06-05 Brake System, Parking in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Body / Chassis Manual.
12. Disconnect shift cable.

REMOVAL AND INSTALLATION (Continued)

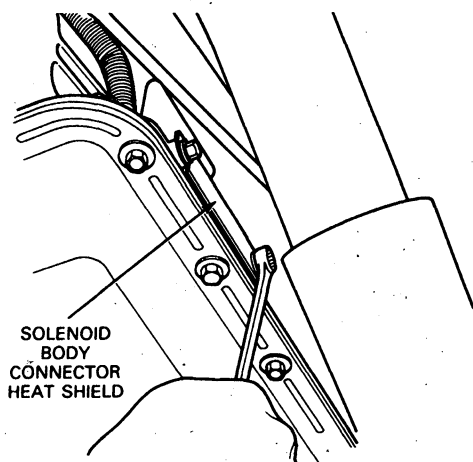
13. On 4x4 models only, (mechanical shift systems) remove shift linkage from transfer case shift lever. Refer to Section 07-07B Transfer Case, Manual Shift in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Powertrain/Drivetrain Manual. Disconnect electrical connector at transfer case.
14. Remove manual lever position sensor connector by squeezing connector tabs and pulling on connector.

CAUTION: Do not attempt to pry tabs with pry bar or screwdriver.



D9160-D

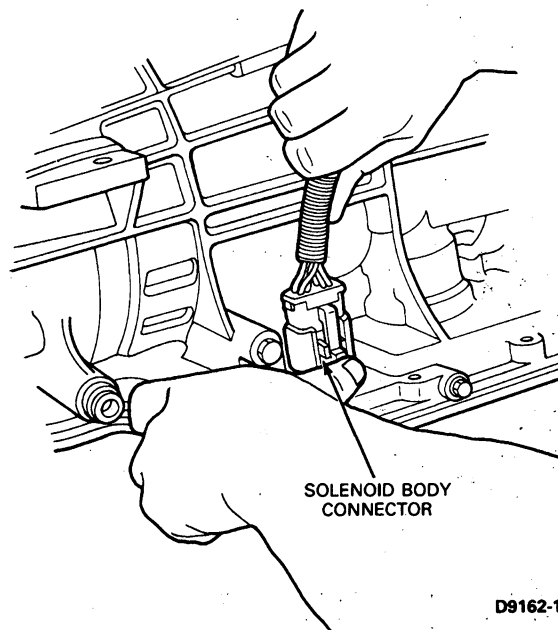
15. To remove solenoid body connector heat shield, loosen two bolts using an 8mm wrench. Remove shield.



D9161-1A

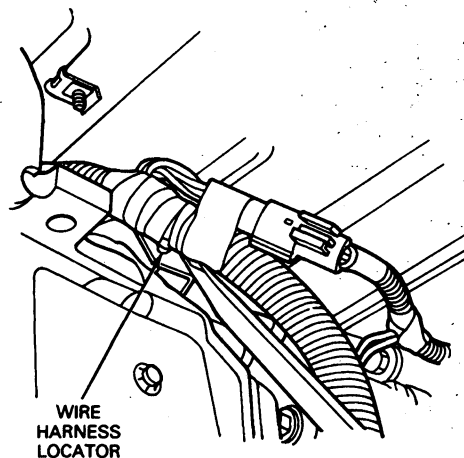
16. Remove solenoid body connector carefully by pushing on the center tab and pulling on the wire harness.

CAUTION: Do not attempt to pry tab with pry bar or screwdriver.



D9162-1A

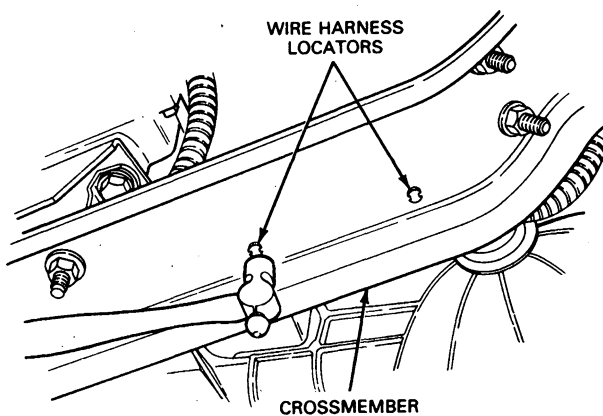
17. On 4x4 models only, remove four-wheel drive switch connector from transfer case. Use care not to overextend tabs.
18. Carefully pry wire harness locator from extension housing wire bracket.



D9165-1A

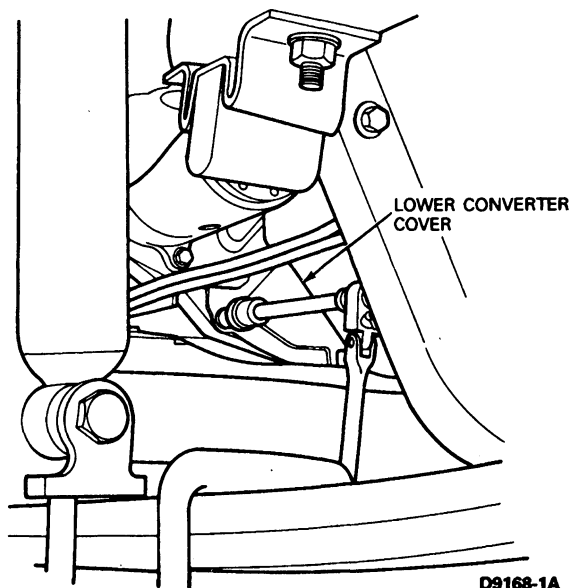
REMOVAL AND INSTALLATION (Continued)

19. On 4x4 models only, remove wire harness locators from left side of crossmember. Discard locators.



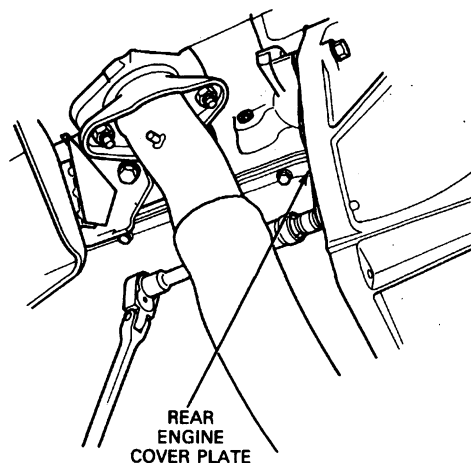
D9166-1A

20. Remove lower converter cover bolts using a 10mm socket and remove cover.



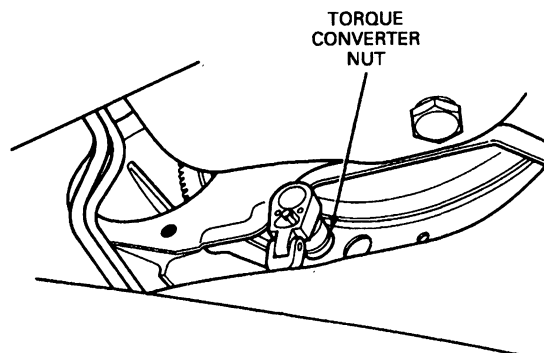
D9168-1A

21. Remove rear engine cover plate bolts.



D9169-1A

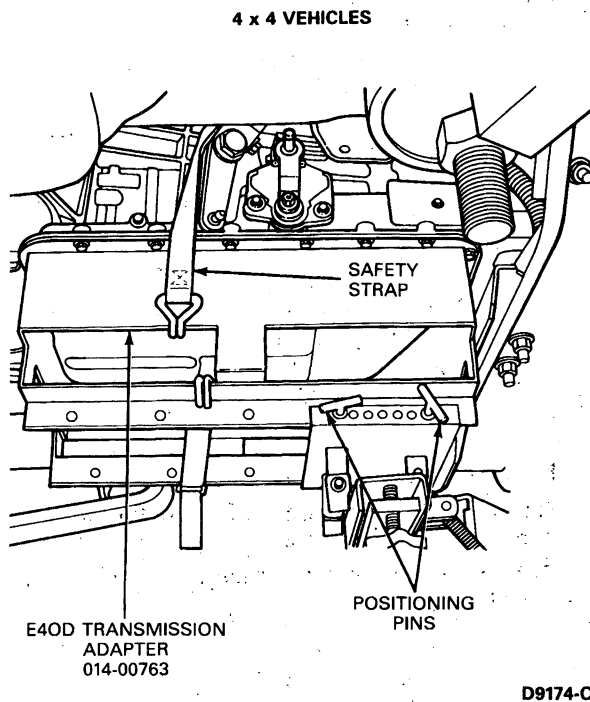
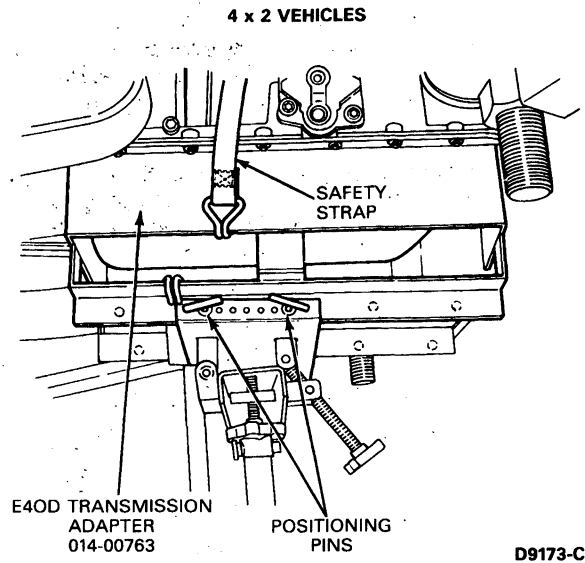
22. Remove starter. Refer to Section 03-06A Starter, Permanent Magnet in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super-Duty Powertrain / Drivetrain Manual.
23. Remove access hole rubber plug. Use a 15 / 16 inch socket to rotate crankshaft to gain access to the converter drain plug. Remove plug. Drain converter.
24. Rotate crankshaft bolt to gain access to converter nuts. Using a 9 / 16 inch socket, remove four converter mounting nuts and discard.



D9172-B

REMOVAL AND INSTALLATION (Continued)

25. Place Rotunda E4OD Transmission Adapter 014-00763 or equivalent on universal transmission jack and position adapter as in following illustration.



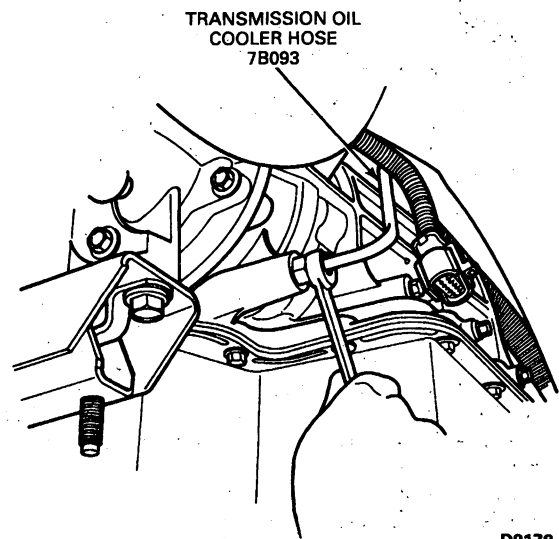
26. Use a safety strap to secure transmission.

27. Remove the two rear transmission mounting pad nuts using an 18mm socket. Remove crossmember to frame bolts and remove crossmember from transmission.

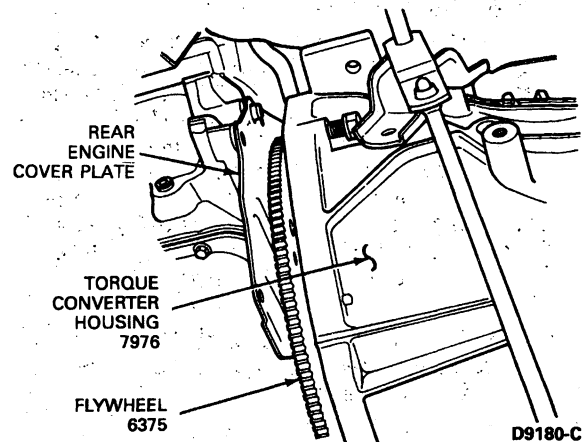
- Transmission may have to be raised to gain adequate clearance to remove crossmember.

NOTE: Case connector fitting should be held with wrench to prevent it from moving when loosening tube nut.

28. Remove transmission cooler lines using a 1/2-inch flare nut wrench from transmission case. Cap cooling lines and plug fittings at transmission.



29. Remove six converter housing bolts.
30. Back out transmission assembly from flywheel and gently lower while watching for any obstructions.

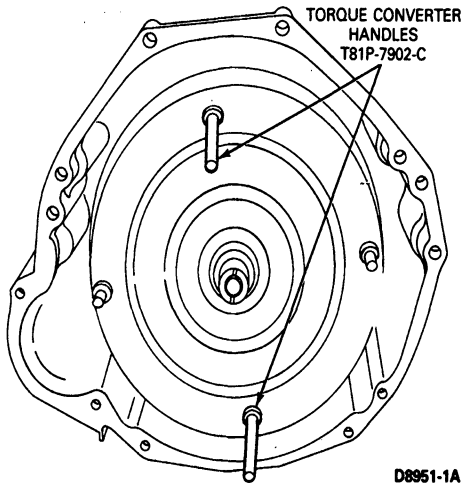


CAUTION: Torque converter is very heavy.

REMOVAL AND INSTALLATION (Continued)

31. Install Torque Converter Handles T81P-7902-C on converter with handles in the 6 and 12 o'clock positions. Carefully remove converter assembly from transmission by pulling evenly on handles.

- Fluid loss will occur when torque converter is removed.



32. Remove transmission filler tube from stub tube.
33. On 4x4 models only, remove transfer case vent hose from detent bracket. Remove the transfer case from the transmission. Refer to Section 07-07A Transfer Case, Electronic Shift or 07-07B Transfer Case, Manual Shift in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super-Duty Powertrain/Drivetrain Manual.

Installation

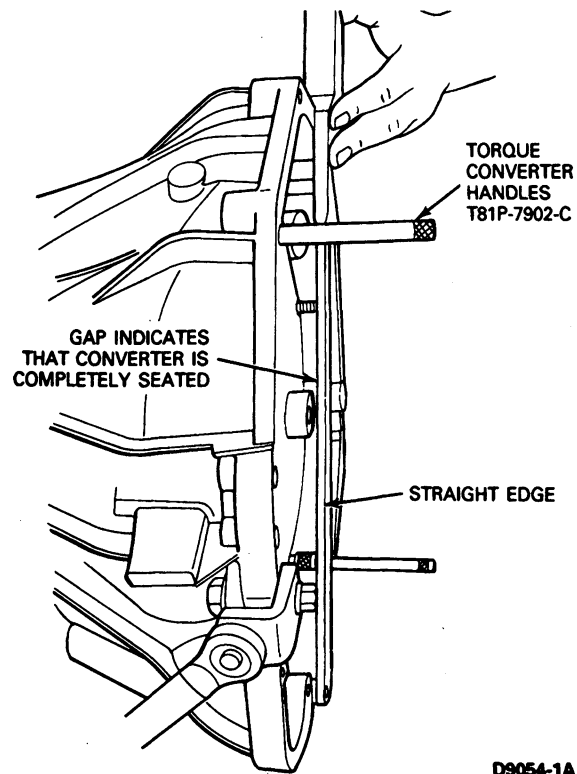
Before installing transmission, check wiring harness for damage. Check connectors for electrical integrity (terminal condition, corrosion, contamination and seal integrity). Repair or replace as required.

1. Place transmission onto E4OD Transmission Adapter 014-00763 or equivalent.
2. On 4x4 models only, install transfer case to transmission. Refer to Section 07-07A Transfer Case, Electronic Shift or 07-07B Transfer Case, Manual Shift in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super-Duty Powertrain/Drivetrain Manual. On F-Super Duty Models, install transmission mounted parking brake. Refer to Section 06-05 Brake System, Parking in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super-Duty Body/Chassis Manual.

CAUTION: Use care when installing converter to avoid damage to the stator support Teflon® seal.

NOTE: Check the converter crankshaft pilot for nicks or damaged surfaces that could cause interference when installing the transmission to engine. Check the converter impeller hub for nicks or sharp edges that would damage the pump seal.

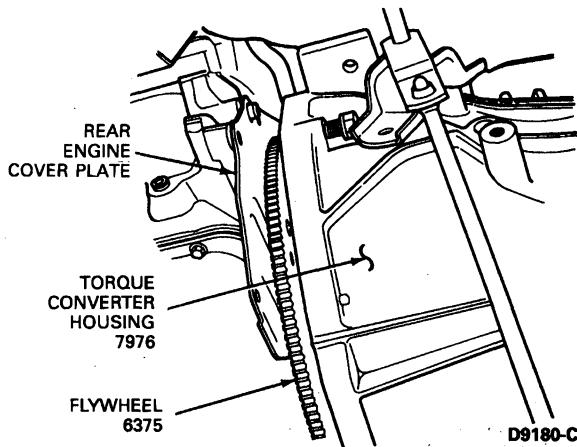
3. Install torque converter using Torque Converter Handles T81P-7902-C. Carry converter with the handles in the 6 and 12 o'clock positions. Push and rotate the converter onto the pump until it bottoms out.
 - Check the seating of the converter by placing a straightedge across the converter housing. There must be a gap between the converter pilot face and the straightedge.



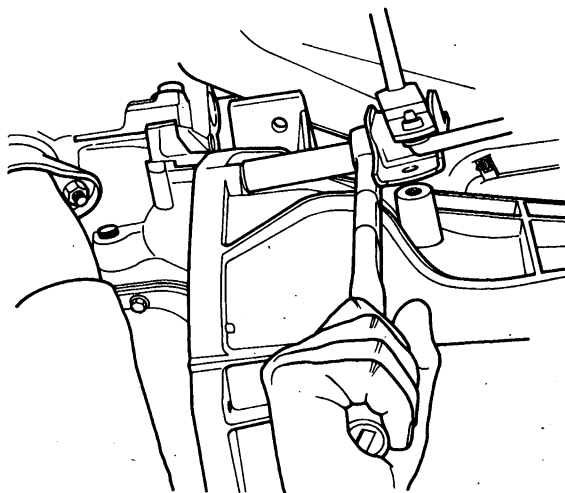
4. Remove converter handles.
5. Check condition of filler tube O-ring, replace if damaged. Install filler tube.
6. Rotate converter studs to align with flywheel mounting holes.

REMOVAL AND INSTALLATION (Continued)

7. Raise transmission into position while watching for any obstructions. Do not allow converter drive flats to disengage from pump gear. Rubber converter drain plug cover may be removed to aid in the alignment of the converter studs. Use care not to damage the flywheel and converter pilot. The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft.

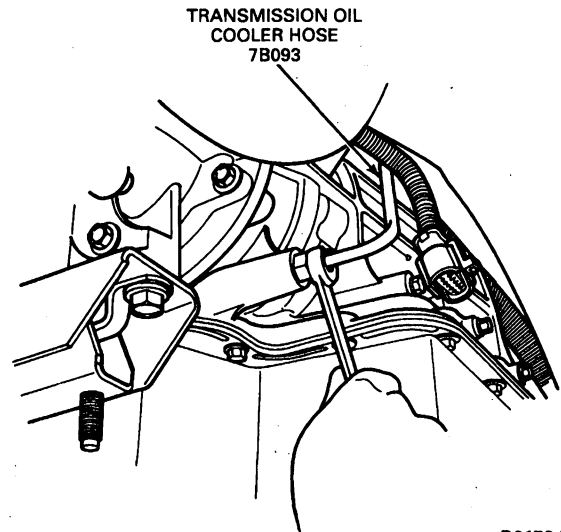


8. Install transmission-to-engine bolts. Alternately snug-up bolts using a 5/8-inch socket. Alternately tighten bolts to 51-70 N·m (38-52 ft-lb) for gas engine applications, or to 66-90 N·m (49-66 ft-lb) for diesel engine applications.

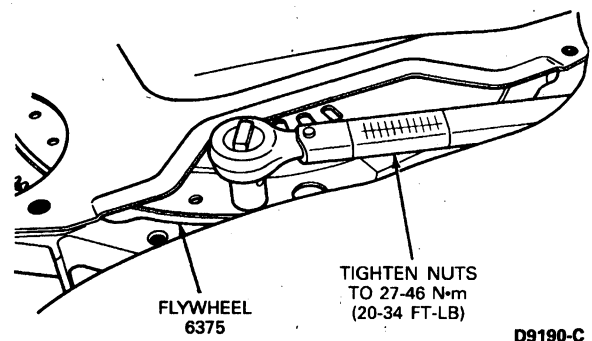


9. Install rubber converter drain plug cover, if removed.
- NOTE:** Case connector fitting should be held with wrench to prevent it from moving when tightening tube nut.

10. Install transmission cooling lines to transmission fittings. Tighten to 24-31 N·m (18-23 ft-lb).



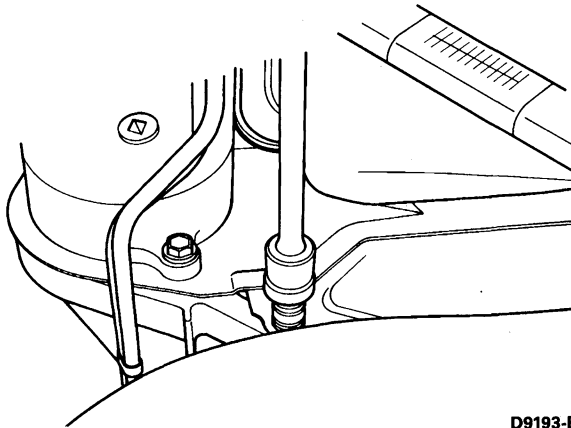
11. Install crossmember and transmission retaining bolts. Make sure that wiring harness is properly routed.
12. Remove safety strap and universal high lift transmission jack.
13. Rotate crankshaft using a 15/16-inch socket on front pulley bolt to gain access to converter studs. Install new stud nuts using a 9/16-inch socket. Tighten to 27-46 N·m (20-34 ft-lb).



14. Install starter motor. Refer to Section 03-06A Starter, Permanent Magnet in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super-Duty Powertrain/Drivetrain Manual.

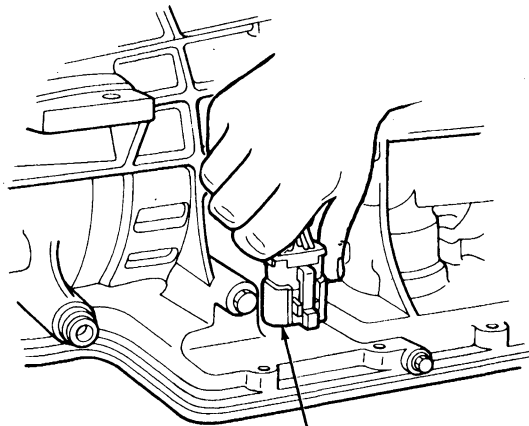
REMOVAL AND INSTALLATION (Continued)

15. Install rear engine plate cover and lower dust cover bolts. Tighten to specifications.



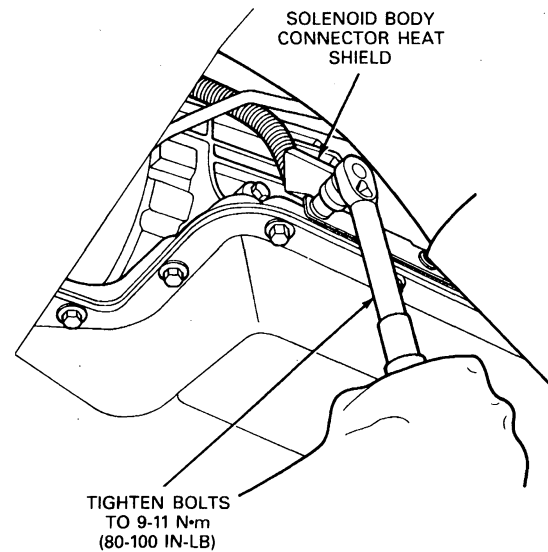
D9193-B

16. Completely seat solenoid body connector into solenoid valve body receptacle by pushing on the top of the connector. An audible click indicates full contact. Verify connection by pulling on harness.

SOLENOID
BODY
CONNECTOR

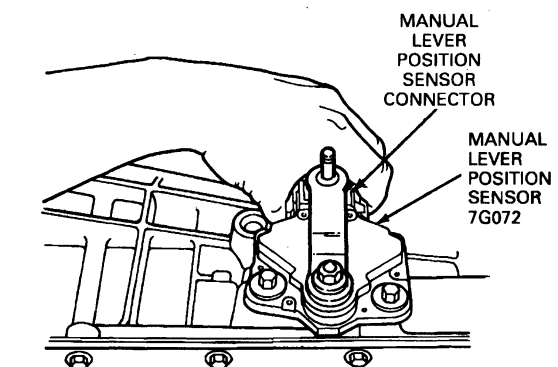
D9195-1B

17. Install solenoid body connector heat shield with off-set bending inward. Tighten to 9-11 N·m (80-100 in-lb).

TIGHTEN BOLTS
TO 9-11 N·m
(80-100 IN-LB)

D9196-C

18. On 4x4 models only, install new wire harness locators into crossmember.
19. Install new wire harness locator into extension housing wire bracket.
20. Install four-wheel drive switch connector, if equipped.
21. Connect transfer case shift linkage, if equipped. Refer to Section 07-07B Transfer Case, Manual Shift in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super-Duty Powertrain / Drivetrain Manual.
22. Install manual lever position sensor connector. An audible click indicates full connection.

MANUAL
LEVER
POSITION
SENSOR
CONNECTORMANUAL
LEVER
POSITION
SENSOR
7G072

D9160-D

23. Install shift cable.
24. Install parking brake cable (F-Super Duty). Refer to Section 06-05 Brake System, Parking in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super-Duty Body / Chassis Manual.

REMOVAL AND INSTALLATION (Continued)

25. Install rear driveshaft. Refer to Section 05-01 Driveshaft, in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super-Duty Powertrain/Drivetrain Manual.
26. On 4x4 models only, install front driveshaft. Refer to Section 05-01 Driveshaft, in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super-Duty Powertrain/Drivetrain Manual.
27. Install skid plate (4x4 vehicles).
28. Install engine charge exhaust pipe and extension pipe.
29. Install nuts retaining exhaust extension pipe to muffler and pipe assembly. Refer to Section 09-00 Exhaust System in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super-Duty Powertrain/Drivetrain Manual.

30. Install bolt retaining engine charge exhaust pipe to transmission housing. Tighten bolt to 66-90 N·m (49-66 ft-lb).
31. Remove safety stands and lower vehicle.
32. Install engine charge exhaust pipe to wastegate housing exhaust outlet, tighten marman clamp.
NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the PCM relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
33. Connect negative battery cables.
34. Fill the transmission to the proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (E4AZ-19582-B) or equivalent. Refer to Fluid Capacity Chart under Specifications.

SECTION 07-03C Transmission, Model S5-42 ZF

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	07-03C-1	REMOVAL AND INSTALLATION	
DESCRIPTION AND OPERATION	07-03C-1	Transmission (4x2)	07-03C-1
		Transmission (4x4)	07-03C-4

VEHICLE APPLICATION

F-Series Vehicles Over 8500 Lbs GVW with 7.3L
Indirect Injection (IDI) Turbo Diesel Engines

DESCRIPTION AND OPERATION

For procedures not unique to the 7.3L IDI turbo diesel engine refer to the following pages in Section 07-03C in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual:

SUBJECT	PAGE
ADJUSTMENTS	
Bearing Preload Adjustment	07-03C-61
DESCRIPTION AND OPERATION	07-03C-2
DIAGNOSIS AND TESTING	
Additional Testing For 4x4 Trucks (Non-Electronic Shift)	07-03C-3
Cold Transmission	07-03C-3
Warm Transmission	07-03C-3
DISASSEMBLY AND ASSEMBLY	
Countershaft	07-03C-60

(Continued)

SUBJECT	PAGE
Gearshift Housing Assembly	07-03C-36
Input Shaft	07-03C-60
Mainshaft	07-03C-44
Shift Lever Assembly	07-03C-35
Shift Rails	07-03C-37
Transmission Front Case	07-03C-39
Transmission Rear Case	07-03C-37
INSPECTION	
Synchronizer Ring / Synchronizer Body Wear Check	07-03C-63
REMOVAL AND INSTALLATION	
Rear Oil Seal, 4x2 Transmissions (Except F-Super Duty)	07-03C-15
Rear Oil Seal, 4x4 and F-Super Duty Series Transmissions	07-03C-16
SPECIAL SERVICE TOOLS / EQUIPMENT	07-03C-65
SPECIFICATIONS	07-03C-64

REMOVAL AND INSTALLATION

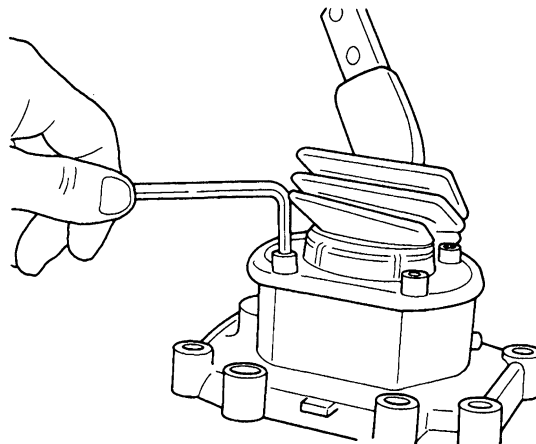
Transmission (4x2)

Removal

- Shift the transmission into neutral.
- Remove the four screws and remove the boot and bezel assembly from the transmission opening cover.
- Remove the two bolts and remove the upper shift lever from the lower shift lever.

CAUTION: Remove lower lever from the vehicle to prevent getting transmission fluid on the floor mat or carpet.

- Remove the four Allen-head capscrews from the shift tower cover and remove the entire shifter assembly from the top of the transmission.



C8734-1A

REMOVAL AND INSTALLATION (Continued)

5. Loosen marman clamp at wastegate housing exhaust outlet.
6. Raise the vehicle on a hoist and position safety stands under the vehicle.
7. Remove bolt retaining engine charge exhaust pipe to transmission housing.
8. Remove nuts retaining exhaust extension pipe to muffler and pipe assembly.
9. Remove engine charge exhaust pipe and extension pipe.
10. Disconnect the backup lamp switch located at the top left hand side of the transmission.
11. If the transmission is to be disassembled, remove the drain plug and drain the oil from the transmission.
12. Position a transmission jack, such as Rotunda Transmission Jack 077-00008 or equivalent under the transmission. Secure the transmission to the jack stand.
13. Remove the driveshaft from the vehicle. Disconnect the clutch linkage from the transmission. Refer to Driveshaft and 08-02, Clutch Controls in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual. Keep transmission in upright position to avoid fluid leakage.
14. On F-Super Duty series vehicles remove the transmission parking brake from the transmission. Refer to Section 06-05, Brake System, Parking, in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Body / Chassis Manual. Keep parking brake in upright position to avoid fluid leakage.
15. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in Crossmember Removal and Installation in Section 07-03C, Transmission, Model S5-42 ZF in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
16. Remove the bolts that retain the transmission to the engine block.
17. Move the transmission to the rear until the input shaft clears the engine flywheel. Lower the transmission from the vehicle. Keep transmission in upright position to avoid fluid leakage.

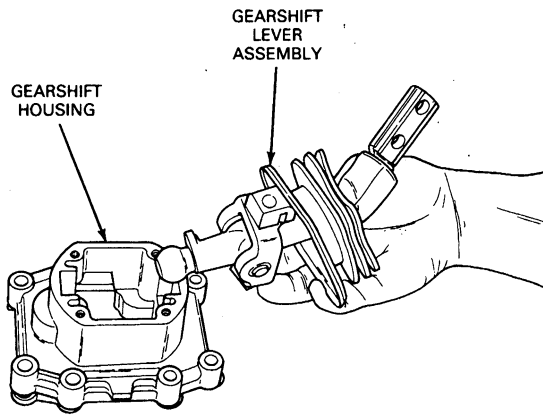
Installation

1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent. Secure the transmission to the jack. Install guide studs in the front case and raise the transmission until the input shaft splines are aligned with the clutch disc splines. The clutch release bearing and hub must be properly positioned in the release lever fork.
2. Slide the transmission forward on the guide studs until it is in position on the front case. Install the attaching bolts and tighten them to 54-68 N-m (40-50 ft-lb). Remove the guide studs and install the two remaining attaching bolts.
3. Install the crossmember as described under Crossmember Removal and Installation in Section 07-03C, Transmission, Model S5-42 ZF in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual. Position the insulator and retainer between the transmission and crossmember. Install bolts and tighten to 60-80 N-m (45-60 ft-lb). Install the nut retaining the insulator and retainer to crossmember. Tighten to 68-94 N-m (50-70 ft-lb). Remove the transmission jack.
4. Connect the clutch linkage. Refer to Section 08-02, Clutch Controls in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
5. Connect the backup lamp switch.
6. On F-Super Duty series vehicles, install the transmission parking brake. Refer to Section 06-05, Brake System, Parking in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Body / Chassis Manual.
7. Install the driveshaft. Refer to Section 05-01, Driveshaft, in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
8. Fill the transmission with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, XT-2-QDX or -DDX E4AZ-19582-B or equivalent. Remove safety stands and lower the vehicle.
9. Install engine charge exhaust pipe and extension pipe.
10. Install nuts retaining extension pipe to muffler and pipe assembly. Refer to Section 09-00.
11. Install bolt retaining engine charge exhaust pipe to transmission housing, tighten bolt to 54-68 N-m (40-50 ft-lb).

CAUTION: Do not use any sealant on gasket.

REMOVAL AND INSTALLATION (Continued)

12. Place a **new**, dry gasket on the upper surface of the gearshift housing. Place the gearshift lever with the attached guide pieces into the guide piece grooves. The slotted ends of these guide pieces must face upward.

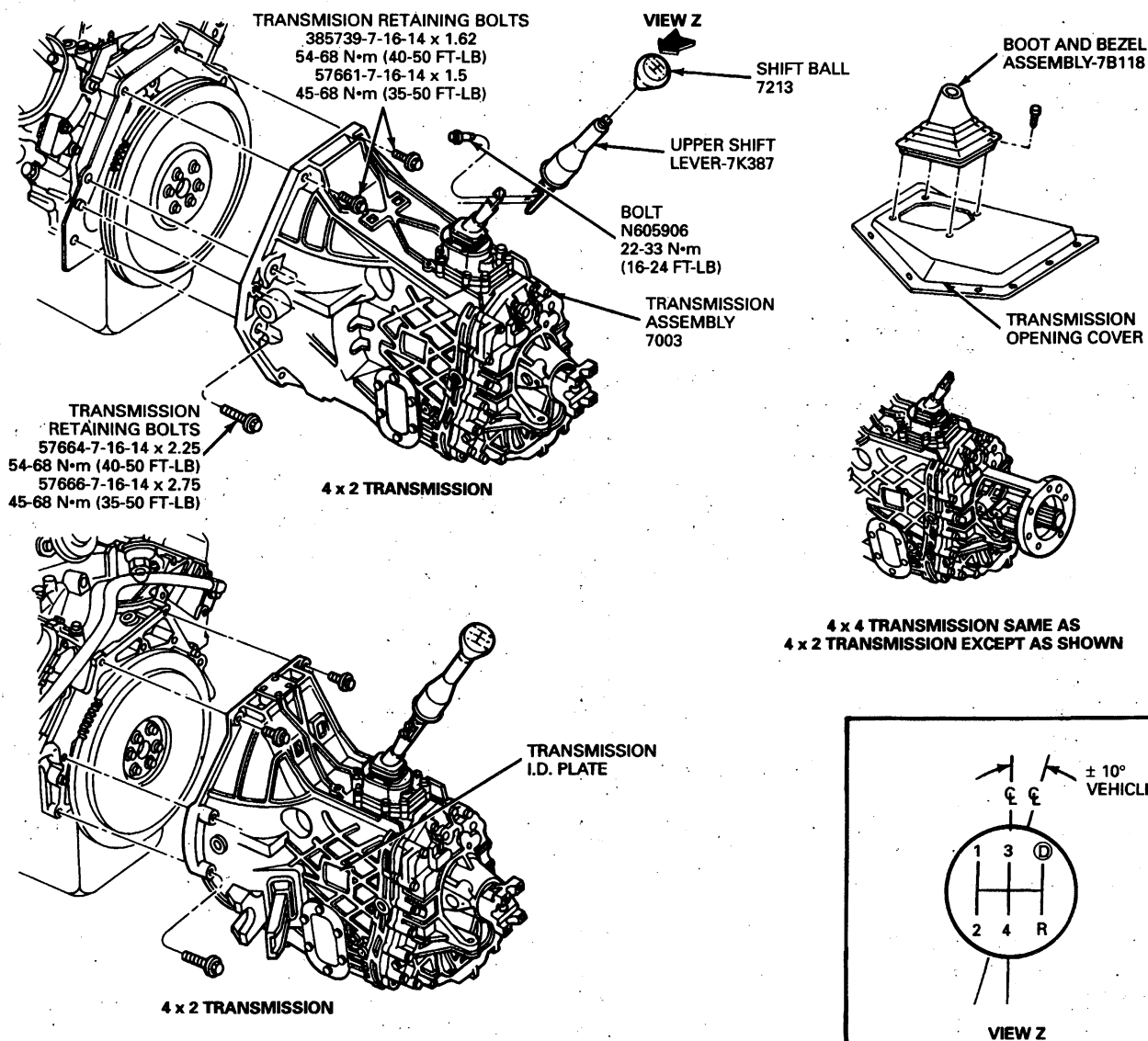


C8727-1A

13. Tighten the four Allen-head capscrews that secure the cover assembly to the gearshift housing to approximately 10 N·m (7 ft-lb).
14. Install the inner boot over the lower shift lever.
15. Install the upper shift lever to the lower shift lever and tighten the two retaining screws to 22-33 N·m (16-24 ft-lb).
16. Install the inner boot and the boot and bezel assembly to the transmission opening cover.
17. Install the shift ball on the upper shift lever if removed.
18. Install engine charge exhaust pipe to wastegate housing exhaust outlet and tighten marman clamp.

REMOVAL AND INSTALLATION (Continued)

Manual Transmission Assembly



C11502-A

Transmission (4x4)

Removal

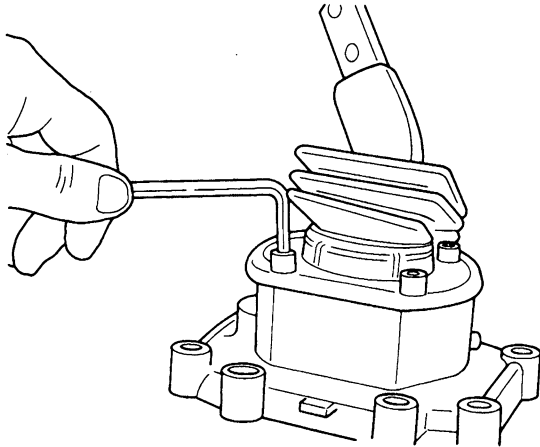
1. Shift the transmission into neutral.

2. Remove the four screws and remove the boot and bezel assembly from the transmission opening cover.

REMOVAL AND INSTALLATION (Continued)

3. Remove the four Allen-head capscrews from the shift tower cover and remove the entire shifter assembly from the top of the transmission.

CAUTION: Remove lower lever from the vehicle to prevent getting transmission fluid on the floor mat or carpet.



C8734-1A

4. Loosen marman clamp at wastegate housing exhaust outlet.
5. Raise the vehicle on a hoist and position safety stands under vehicle.
6. Remove bolt retaining engine charge exhaust pipe to transmission housing.
7. Remove nuts retaining exhaust extension pipe to muffler and pipe assembly.
8. Remove engine charge exhaust pipe and extension pipe.
9. If transmission is to be disassembled, remove the drain plugs and drain the transmission and transfer case.
10. Remove the rear driveshaft from the vehicle.
11. Remove the front driveshaft from the vehicle. Refer to Section 05-01, Driveshaft in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
12. Disconnect the backup lamp switch.
13. Disconnect the clutch linkage from the transmission.
14. If equipped, remove the skid pan from beneath the transfer case.
15. Remove the transfer case according to the procedure outlined in Section 07-07B, Transfer Case, Manual Shift in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
16. Position a transmission jack, such as Rotunda Transmission Jack 077-00008 or equivalent, under transmission. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in Crossmember Removal and Installation in Section 07-03C, Transmission, Model S5-42 ZF in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.
17. Remove the bolts that retain the transmission to the engine block.
18. Move the transmission to the rear until the input shaft clears the engine flywheel housing. Lower the transmission from the vehicle.

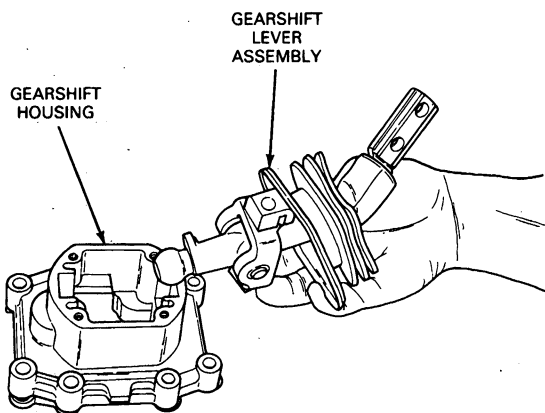
Installation

1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent, and install two guide studs in the transmission front case top holes, to guide the transmission into position. Join together the transmission and engine block mating surfaces.
2. Install the two lower bolts and tighten to 54-68 N·m (40-50 ft·lb). Remove the guide studs and install the upper bolts.
3. Place the rear support bracket in position and install the retaining bolts. Refer to Crossmember Installation in Section 07-03C, Transmission, Model S5-42 ZF in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual. Tighten the bolts to 60-80 N·m (45-60 ft·lb).
4. Install the two bolts at the rear support insulator bracket. Remove the transmission jack.
5. Position the transfer case on the transmission jack. Position the transfer case on the transmission, using care to guide the transfer case shift lever through the opening in the floor pan. Install the gasket and six retaining bolts. Tighten the bolts to specifications listed in the appropriate transfer case section in Group 07 in this manual.
6. Install the front driveshaft.
7. Install the rear driveshaft.
8. Fill transfer case and transmission with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX E4AZ-19582-B or equivalent.
9. Connect the backup lamp switch.
10. Install engine charge exhaust pipe and extension pipe.
11. Install nuts retaining extension pipe to muffler and pipe assembly, tighten nuts to 23-33 N·m (17-24 ft·lb).
12. Install bolt retaining engine charge exhaust pipe to transmission housing, refer to the appropriate transmission section in Group 07.
13. Remove safety stands and lower vehicle.

REMOVAL AND INSTALLATION (Continued)

14. Place a **new**, dry gasket on the upper surface of the gearshift housing. Place the gearshift lever with the attached guide pieces into the guide piece grooves. The slotted ends of these guide pieces must face upward.

CAUTION: Do not use any sealant on gasket.



C8727-1A

15. Tighten the four Allen-head capscrews that secure the cover assembly to the gearshift housing to approximately 10 N-m (7 ft-lb).
16. Install the inner boot over the lower shift lever.
17. Install the upper shift lever to the lower shift lever and tighten the two retaining screws to 22-33 N-m (16-24 ft-lb).
18. Install the inner boot and the boot and bezel assembly to the transmission opening cover.
19. Install the shift ball on the upper shift lever if removed.
20. Install engine charge exhaust pipe to wastegate housing exhaust outlet and tighten marman clamp.

GROUP

EXHAUST 09

SECTION 09-00 Exhaust Pipes, Mufflers and Converters

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	09-00-1	REMOVAL AND INSTALLATION (Cont'd.)	
DESCRIPTION	09-00-1	Heat Shields	09-00-4
REMOVAL AND INSTALLATION		Muffler and Outlet Pipe Assembly.....	09-00-2
Engine Charge Exhaust Pipe	09-00-3	Turbocharger Exhaust Inlet.....	09-00-3
Exhaust Crossover Pipe.....	09-00-2	SPECIFICATIONS	09-00-6
Exhaust Y-collector Pipe.....	09-00-2		

VEHICLE APPLICATION

F-250-350 and F-Super Duty Vehicles Equipped with 7.3L IDI Turbo Diesel Engines

DESCRIPTION

For procedures not unique to the 7.3L IDI turbo diesel engine refer to the following pages in section 09-00 in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual:

SUBJECT	PAGE
ADJUSTMENTS	
Exhaust System Alignment.....	09-00-29
DESCRIPTION	09-00-01
DIAGNOSIS AND TESTING	

(Continued)

SUBJECT	PAGE
Diagnosis Guides	09-00-2
Restricted Exhaust System Test, Gasoline Engines	09-00-2
REMOVAL AND INSTALLATION	
Hanger Brackets	09-00-6
Muffler and Outlet Pipe Assembly.....	09-00-4
Muffler Heat Shields.....	09-00-6
SPECIAL SERVICE TOOLS / EQUIPMENT.....	09-00-31
SPECIFICATIONS	09-00-30
VEHICLE APPLICATION	09-00-1

REMOVAL AND INSTALLATION

The exhaust system components are removed, disassembled, assembled and installed using standard tools and procedures. Only remove components to the extent necessary to replace worn or damaged components.

Always refer to the Master Parts Catalog for parts usage and interchangeability before replacing a component part of the exhaust system.

REMOVAL AND INSTALLATION (Continued)

Muffler and Outlet Pipe Assembly**Removal**

1. Remove muffler and outlet pipe assembly clamp and U-bolt assemblies as required to remove worn or damaged components.
2. Disconnect muffler and outlet pipe assembly bracket and insulator assemblies.
3. Remove muffler and outlet pipe assembly. It may be necessary to heat the muffler / converter joint in order to separate the muffler assembly from the converter.
4. On SuperCab vehicles, remove extension pipe.

Installation

CAUTION: Make sure positioning tabs and slots provided at the converter / muffler assembly connections are properly aligned to avoid ground-out conditions with chassis components during assembly.

1. On models using gaskets, clean mating surfaces thoroughly and install a new gasket.
2. Loosely assemble the extension pipe.
3. Place muffler and outlet pipe assembly in vehicle by sliding in over axle housing.
4. Loosely assemble the muffler and outlet pipe to extension pipe.

NOTE: Avoid use of oils or silicone since they do not dry and may allow the insulator to slip back off once it is installed.

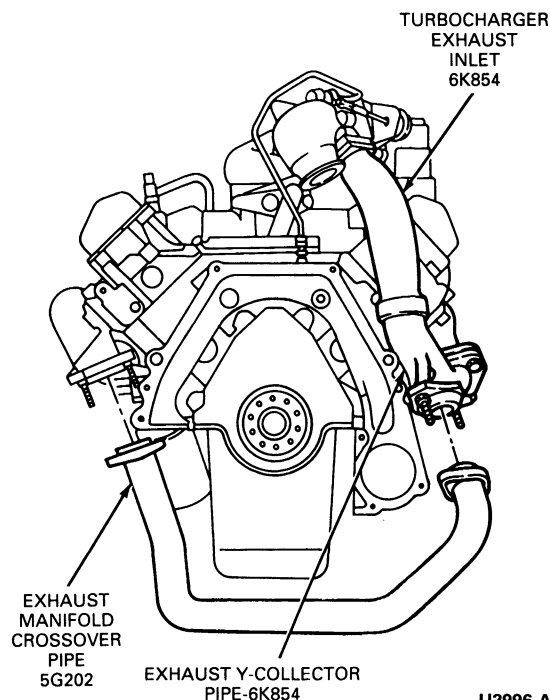
5. Apply a soap solution to metal support rods on muffler and outlet pipe assembly.
6. Force metal support rods through rubber insulators.
7. Attach hanger bracket clamps and U-bolts and tighten to specifications shown on illustration.
8. Tighten any gasket joints, then install and tighten the sealing clamp at the muffler-to-outlet pipe joint.

CAUTION: To make sure joint seals correctly, the correct clamp must be used.

9. Tighten extension pipe bolts to specifications.

Exhaust Crossover Pipe**Removal**

1. Raise vehicle.
2. Remove nuts retaining exhaust crossover pipe to left exhaust manifold.
3. Remove nuts retaining exhaust crossover pipe to Y-collector pipe.
4. Remove exhaust crossover pipe.

**Installation**

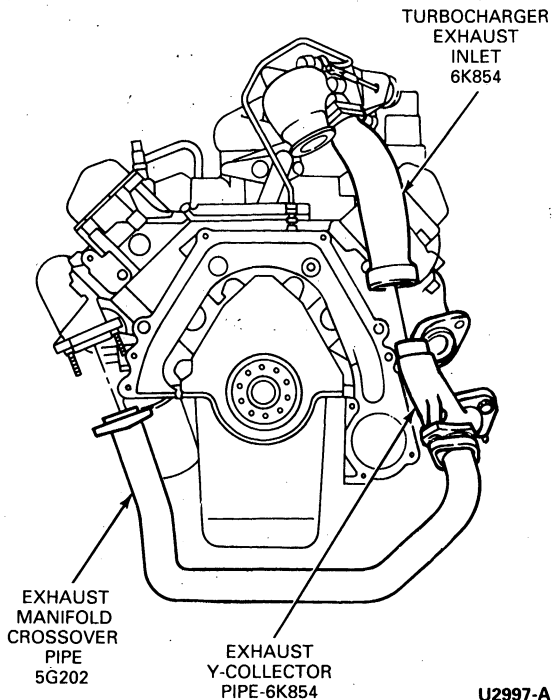
1. Install exhaust crossover pipe.
2. Install nuts retaining exhaust crossover pipe to Y-collector pipe, tighten nuts to 42 N·m (31 ft-lb).
3. Install nuts retaining exhaust crossover pipe to left exhaust manifold, tighten nuts to 42 N·m (31 ft-lb).
4. Lower vehicle.
5. Start engine and inspect for exhaust leaks.

Exhaust Y-collector Pipe**Removal**

1. Raise vehicle.
2. Remove nuts retaining exhaust crossover pipe to left exhaust manifold.
3. Remove bolts retaining Y-collector pipe to right exhaust manifold.
4. Remove crossover pipe and Y-collector pipe as an assembly. Rotate assembly back and forth while pulling down to remove Y-collector pipe from turbocharger exhaust inlet.
5. Remove nuts retaining Y-collector pipe to exhaust crossover pipe.
6. Remove exhaust crossover pipe.

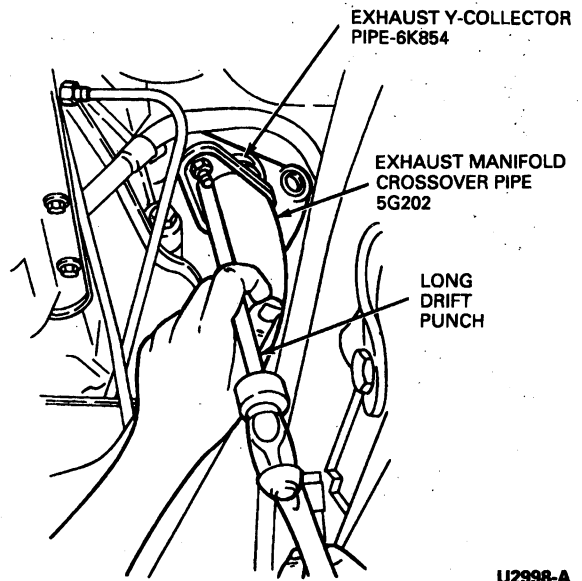
REMOVAL AND INSTALLATION (Continued)

7. Remove exhaust Y-collector pipe.

**Installation**

1. Place exhaust Y-collector pipe in position.
2. Loosely install nuts retaining Y-collector pipe to exhaust crossover pipe.
3. Loosely install nuts retaining crossover pipe to left exhaust manifold.

4. Install Y-collector pipe into turbo charge exhaust inlet. Using a long drift punch tap on Y-collector flange to help installation.
5. Install bolts retaining Y-collector pipe to right exhaust manifold, tighten bolts to 42 N·m (31 ft-lb).
6. Tighten nuts retaining crossover pipe to left exhaust manifold to 42 N·m (31 ft-lb).
7. Tighten nuts retaining crossover pipe to Y-collector to 42 N·m (31 ft-lb).
8. Lower vehicle.
9. Start engine and inspect for exhaust leaks.

**Turbocharger Exhaust Inlet****Removal**

1. Remove turbocharger assembly as outlined in Section 03-12B in this Supplement.
2. Remove heat shield from turbocharger exhaust inlet.
3. Remove four nuts retaining turbocharger exhaust inlet to turbocharger assembly.
4. Remove turbocharger exhaust inlet.

Installation

1. Install turbocharger exhaust inlet to turbocharger assembly.
2. Install turbocharger exhaust inlet retaining bolts. Tighten nuts to 35 N·m (26 ft-lb).
3. Install turbocharger assembly as outlined in Section 03-12B in this Supplement.

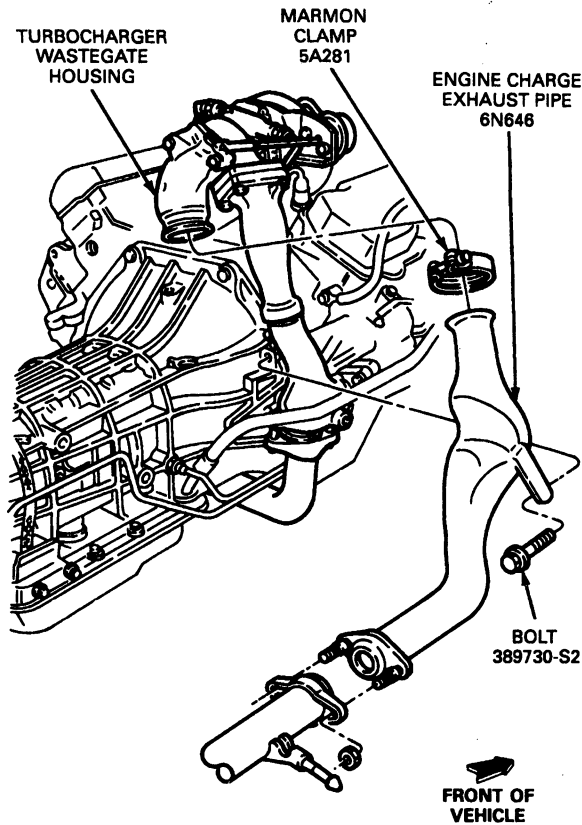
4. Start engine and inspect for leaks.

Engine Charge Exhaust Pipe**Removal**

1. Loosen marman clamp enough to remove engine charge exhaust pipe from turbocharger wastegate housing.
2. Raise vehicle.
3. Remove bolts retaining engine charge exhaust pipe to extension pipe.
4. Remove bolt retaining engine charge exhaust pipe to transmission housing.

REMOVAL AND INSTALLATION (Continued)

5. Remove engine charge exhaust pipe.



U2999-A

Installation

1. Install engine charge exhaust pipe.
2. Install bolts retaining engine charge exhaust pipe to extension pipe. Tighten bolts to 23-33 N-m (17-24 ft-lb).
3. Install bolt retaining engine charge exhaust pipe to transmission housing. Refer to Section 07-01A for automatic transmissions or Section 07-03C for manual transmissions in the 1993 Econoline / F-150, F-250, F-350 / Bronco / F-Super Duty Powertrain / Drivetrain Manual.

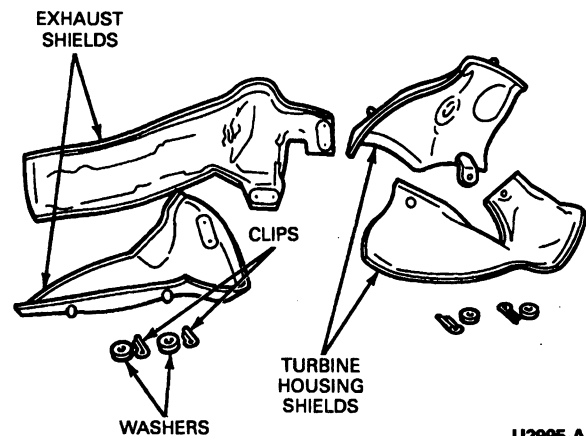
4. Lower vehicle.
5. Install engine charge exhaust pipe to turbo charger wastegate housing and tighten marman clamp.
6. Start engine and inspect for leaks.

Heat Shields

Removal

1. Remove retaining clips from heat shield.
2. Remove heat shield.

NOTE: It is important that all heat shields are reinstalled correctly or heat damage to other components may occur.



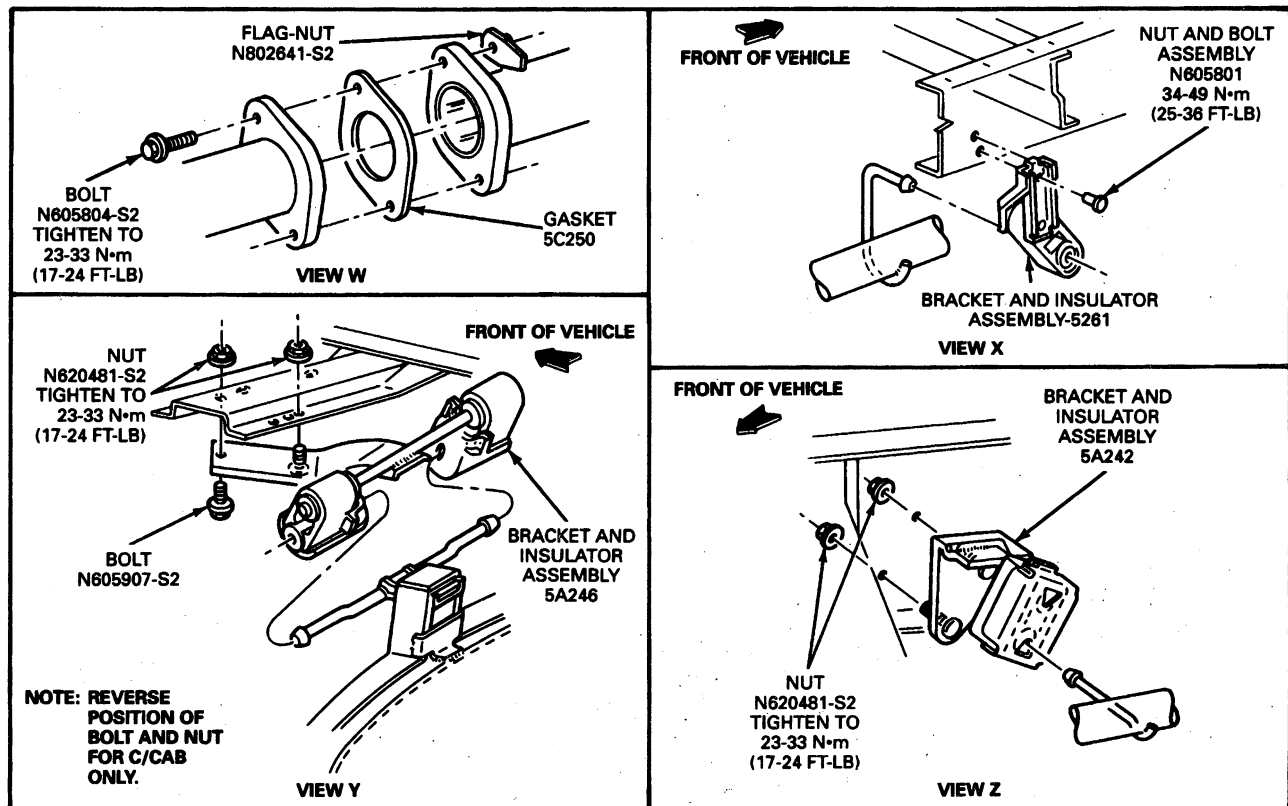
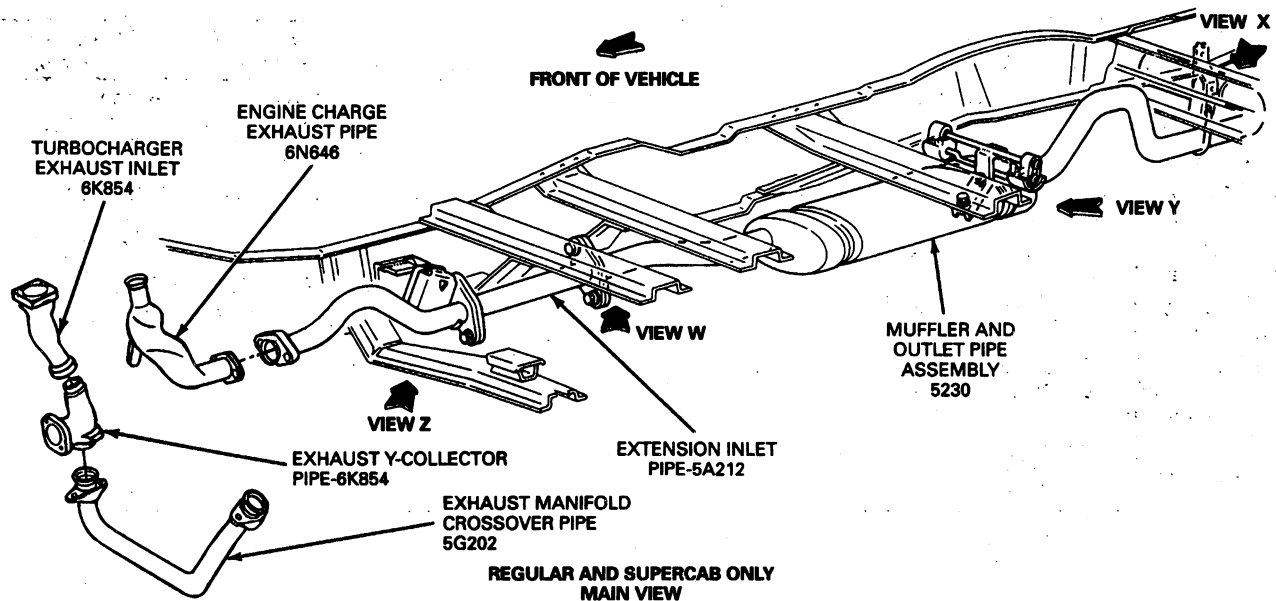
U2995-A

Installation

1. Install heat shield.
2. Install heat shield retaining clips.

REMOVAL AND INSTALLATION (Continued)

F-250, F-350 and F-Super Duty 7.3L Turbo Diesel Engine Exhaust System



U3000-A

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	Ft-Lb
F-250-350, F-Super Duty, 7.3L Diesel		
Stud, Manifold	40-50	30-37
Nut, Y-Pipe-to-Manifold	34-46	25-36
Nuts, Bracket-to-Crossmember or Frame	23-33	17-24
Bolt, Extension Pipe-to-Muffler Inlet Pipe	23-33	17-24
Nut, Exhaust Crossover to Left Exhaust Manifold	34-46	25-36
Nut, Exhaust Crossover to Y-collector Pipe	34-46	36-36
Bolt, Y-collector Pipe to Right Exhaust Manifold	34-46	25-36
Nut, Turbocharger Exhaust Inlet to Turbocharger	32-38	24-28

TORQUE LIMITS — EXHAUST SYSTEM BOLTS AND NUTS

Bolt or Nut Diameter	Class 9.8 (Grade 5)	Class 10.9 (Grade 8)
8mm (5 / 16 Inch)	20-27 N-m (14-19 Ft-Lb)	26-35 N-m (20-25 Ft-Lb)
10mm (3 / 8 Inch)	37-50 N-m (28-36 Ft-Lb)	47-64 N-m (34-47 Ft-Lb)
12mm (7 / 16 Inch)	65-90 N-m (48-66 Ft-Lb)	80-110 N-m (59-80 Ft-Lb)

UNLESS OTHERWISE SPECIFIED, TORQUE RANGES MAY BE USED FOR FITTING OR FASTENER DIAMETERS AS INDICATED.

ELECTRICAL DISTRIBUTION

GROUP 18

SECTION 18-01 Wiring and Circuit Protection

SUBJECT	PAGE	SUBJECT	PAGE
VEHICLE APPLICATION	18-01-1	REMOVAL AND INSTALLATION	
DESCRIPTION	18-01-1	Engine Wiring Harness	18-01-1

VEHICLE APPLICATION

F-250-350 and F-Super Duty Vehicles Equipped with 7.3L Indirect Injection (IDI)

DESCRIPTION

For procedures not unique to 7.3L IDI Turbo Diesel Engine refer to the following pages in section 18-01 in the 1993 Econoline/F-150, F-250, F-350/Bronco/F-Super Duty Body/Chassis Manual:

SUBJECT	PAGE
DESCRIPTION	
Fuse Link	18-01-3

(Continued)

SUBJECT	PAGE
Fuse Panels	18-01-1
DIAGNOSIS AND TESTING	
Fuse Link Continuity Test	18-01-5
REMOVAL AND INSTALLATION	
Fuse Link	18-01-6
Harness Connectors	18-01-9
SPECIAL SERVICE TOOLS	18-01-64
SPECIFICATIONS	18-01-56

REMOVAL AND INSTALLATION

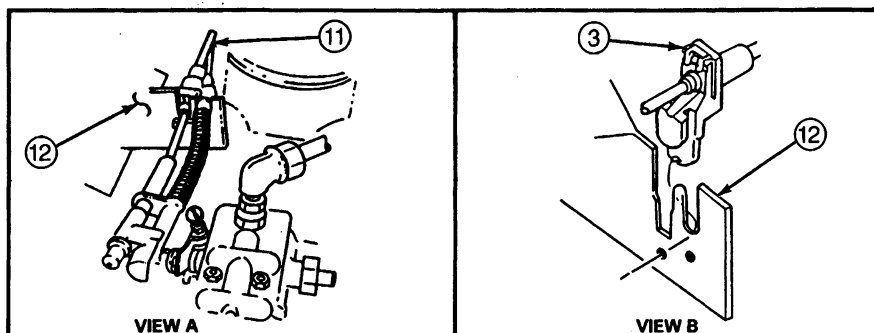
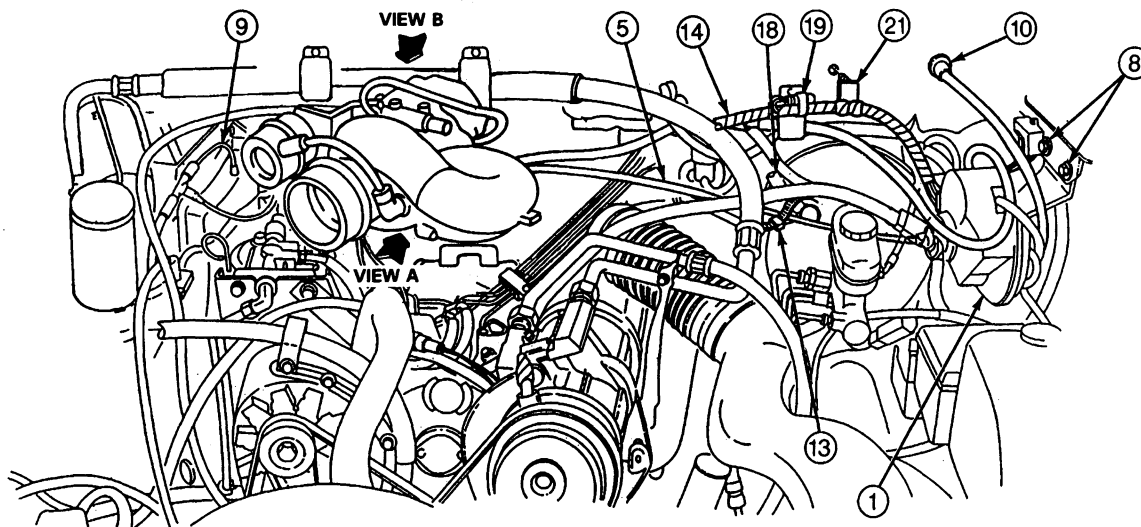
Engine Wiring Harness

Removal and Installation

1. Disconnect battery ground cables from both batteries.
2. Remove air cleaner housing assembly.
3. Remove glow plug protective cover.
4. Disconnect engine harness from chassis harness.
5. Disconnect glow plug leads, fuel injection pump leads, water temperature sender lead, warning switch lead, oil pressure sender lead, wiring from glow plug controller, water in fuel light, fuel heater, and fuel filter restriction indicator wires.
6. Remove two nuts securing engine harness at injection pump drive gear cover and remove harness.
7. For installation, follow removal procedure in reverse order.

REMOVAL AND INSTALLATION (Continued)

Wiring, Engine, F-250-350 and F-Super Duty with 7.3L IDI Turbo Diesel Engine



K20257 -A

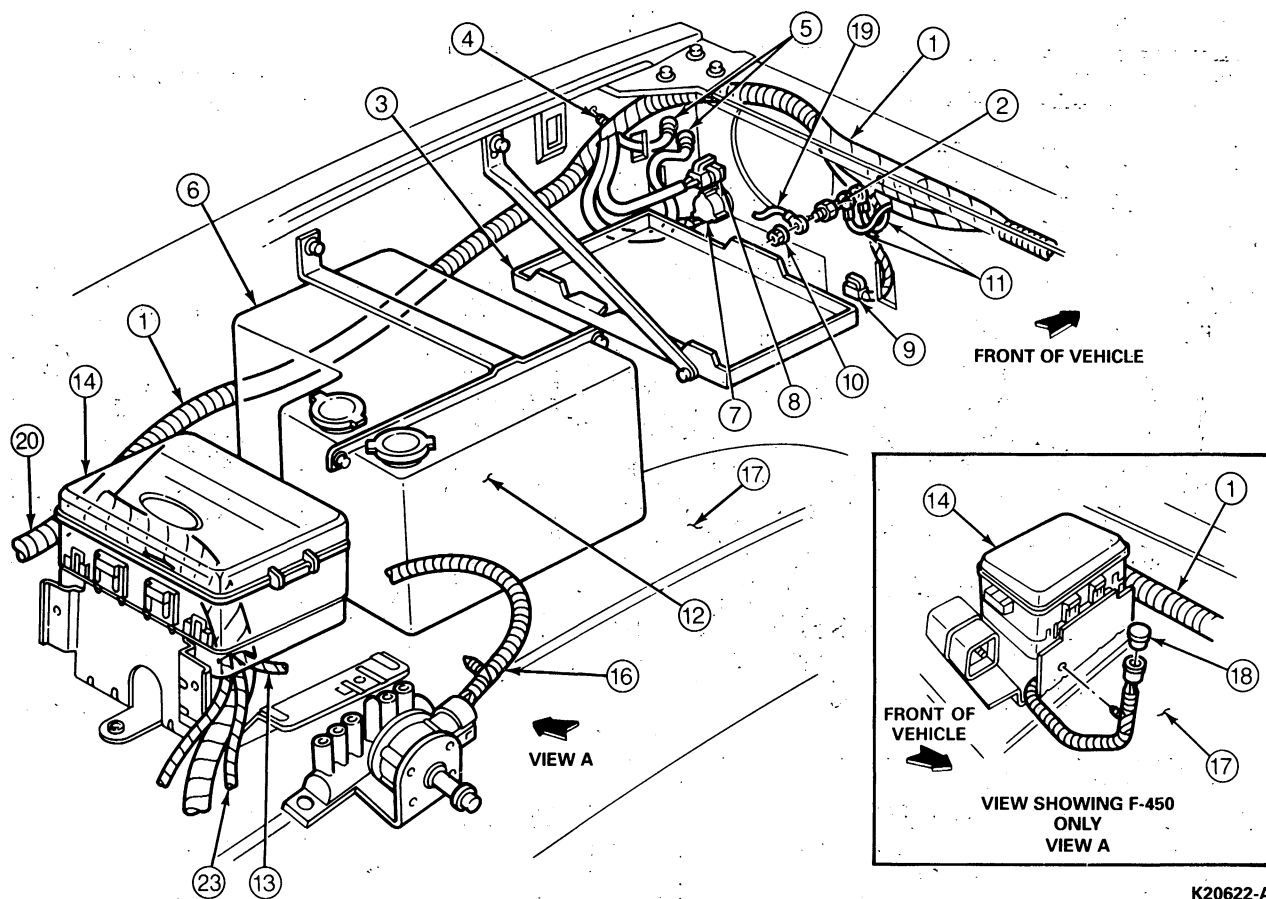
Item	Part Number	Description
1	9C734	Servo Assembly
2	—	Air Cleaner
3	9D726	Clip
4	9E453	Reservoir and Bracket Assembly
5	9A825	Actuator Assembly
7	34657-S36	Nut 8-11 N·m (71-97 In·Lb)
8	N605902-S2	Bolt 15-18 N·m (11.1-13.2 Ft·Lb)

(Continued)

Item	Part Number	Description
9	9E802	Hose Assembly
10	9E802	Hose Assembly
11	9A758	Accelerator Cable
12	9728	Throttle Bracket Assembly
13	95874-S	Strap
14	9A451	Wiring Assembly
18	—	Brake Booster Hose
19	—	To Hood Light
21	—	Clip

REMOVAL AND INSTALLATION (Continued)

Wiring, L.H. Fender Apron and Front End, F-Series



K20622-A

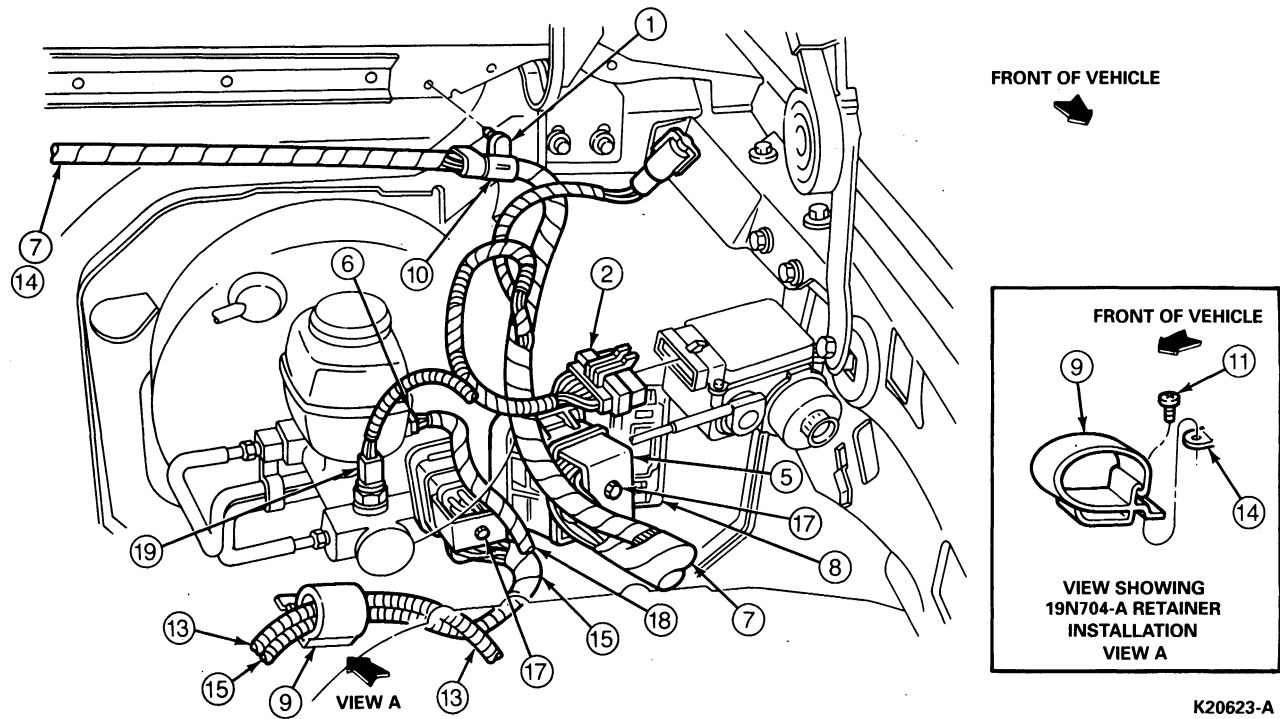
Item	Part Number	Description
1	12A581	Wiring Assembly
2	N806925-S36MG	Stud
3	—	Battery Tray
4	—	Locator Position in Hole Provided
5	—	To L.H. Park
6	—	Coolant Reservoir
7	—	To L.H. Park and Turn Lamp
8	—	To L.H. Headlamp
9	—	To Canadian Running Lamps
10	N621906-S36	Nut
11	12A581	Body Grounds

(Continued)

Item	Part Number	Description
12	—	Windshield Washer Reservoir
13	—	To Windshield Washer Reservoir
14	—	Power Network Box
15	—	Low Vacuum Warning Switch and Bracket Assembly
17	—	Fender Apron
18	14A457	Cap (F-Super Duty Only)
19	14301	Chassis Ground for Continuation
20	—	To Bulkhead Connector
23	—	To Brake Sensor

REMOVAL AND INSTALLATION (Continued)

Wiring, Dash Panel, 7.3L IDI Turbo Diesel with Manual Transmission



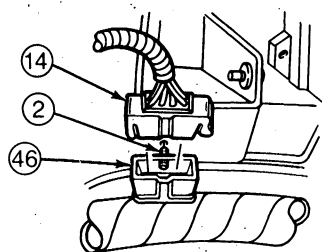
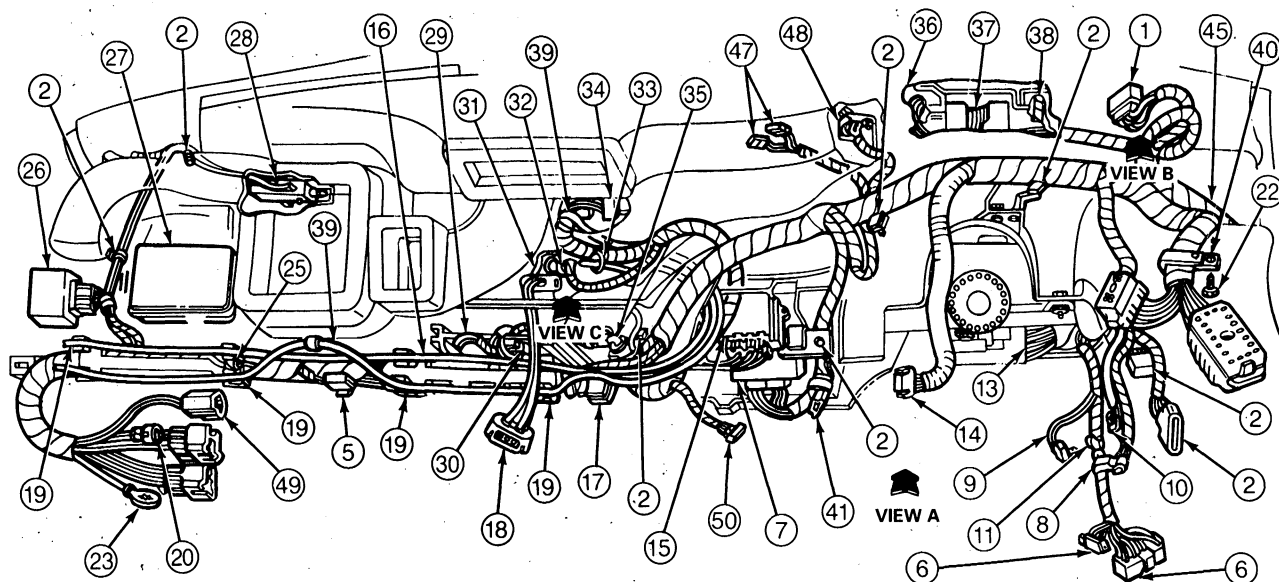
Item	Part Number	Description
1	—	Position Locator in Hole Provided
2	—	To Speed Control
5	—	To 14401 Wiring Assembly
6	—	To Brake Booster
7	12A581	Wiring Assembly
8	—	Plug Reference
9	19N704	Clip

(Continued)

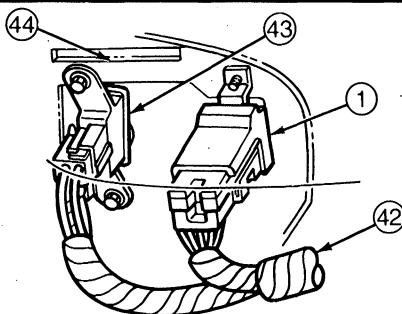
Item	Part Number	Description
10	—	To 15A702 Wiring
11	N381801-S55X	Screw
13	15525	Wiring Assembly
14	—	Dash Panel
15	14405	Wiring Assembly, 76 Way Bulkhead
17	—	Bulkhead Bolt (Torque to 4.5 - 6.8 N-m)
19	—	To Brake Pressure Switch

REMOVAL AND INSTALLATION (Continued)

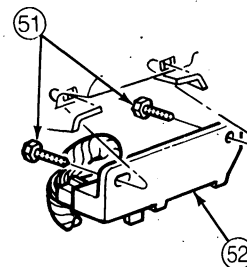
Wiring, Instrument Panel, Diesel Engines



VIEW SHOWS LOCATION OF CLUTCH
INTERLOCK CONNECTION ON AUTOMATIC
TRANSMISSION VEHICLES
VIEW A



VIEW SHOWS HEADLAMP SWITCH CONNECTION
VIEW B



VIEW SHOWS DELETE BRACKET FOR
OVERSPEED WARNING TAKE OUT
W/O R.K.E. + T.A.T.S.
VIEW C

K20624-A

Item	Part Number	Description
1	—	To Headlamp Switch
2	—	Locator Position in Hole Provided
5	—	To PSOM Test Circuit
6	—	To Multi-Function Switch
7	—	Remote Keyless Entry Module
8	—	To Stoplamp Switch
9	—	E4OD Pigtail
10	—	To Park Signal Lamp Switch
11	—	Clip
13	—	To Ignition Switch
14	—	To Clutch Interlock Switch
15	—	To Warning Buzzer Chime
16	—	To Bowden Cable
17	—	To Trailer Brake Controller
18	—	Vacuum
19	14A099	Shield (2)

(Continued)

Item	Part Number	Description
20	—	To Right Courtesy Lamp Switch
22	N606678-S36	Screw
23	—	To Ground
25	—	To Brake Anti-Lock Module Test Circuit
26	17D539	Wiper Control Module
27	—	To Rear Brake Anti-Lock Module
28	—	To Glovebox
29	—	Cigar Lighter
30	—	To Ashtray Wiring
31	—	To Heater Mode Switch
32	—	To A / C Illumination
33	—	To A / C Blower Switch
34	—	To Radio
35	—	To Power Point
36	—	To Cluster (Plug A)

(Continued)

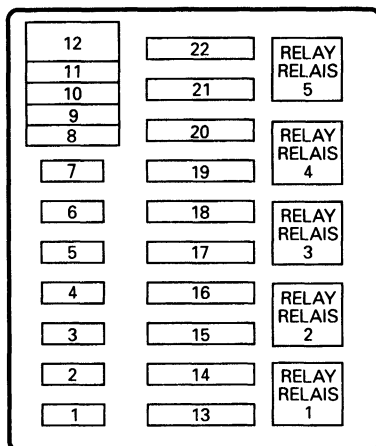
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
37	—	To PSOM
38	—	To Cluster (Plug B)
39	—	Radio Antenna
40	14A282	Retainer Assembly
41	—	Remote Keyless Entry Programming Connector
42	14401	Wiring Assembly
43	—	Dual Fuel Tanks Switch
44	—	Instrument Panel
45	—	To Fuse Box

(Continued)

Item	Part Number	Description
46	14B155	CAP
47	—	To Total Anti-Theft (T.A.T.) Module
48	—	To 3x3 Warning Module
49	—	To Clearance Lamp (F-Series Only)
50	—	Connector (See View C)
51	N803876-S36B	Screw
52	14A163	Retainer Assembly
54	—	Generic Scan Tool Connector

Fuse Box, Power Distribution Identification



K20625-A

FUSE POSITION	AMPS	CIRCUITS PROTECTED
1	20A	Audio Power
2	—	Not Used
3	30A	Horn; Speed Control; Headlamp Flash-to Pass; Daytime Running Lamps (Canada Only)
4	25A	Trailer Back Up and Running Lamps
5	15A	Back Up Lamps; Daytime Running Lamp Module (Canada Only); Trailer Battery Charge Relay; Speed Control
6	10A	Trailer RH Stop / Turn Lamp
7	10A	Trailer LH Stop / Turn Lamp
8	—	Not Used

(Continued)

FUSE POSITION	AMPS	CIRCUITS PROTECTED
9	(20A Maxi) ^a	(Powertrain Control System) ^a
10	20A Maxi	Starter Relay Coil; Instrument Panel Fuses: 15, 18
11	20A Maxi	Glow Plug Controller Relay; Fuel Shut-Off Solenoid; Cold Idle Solenoid
12	(Diode) ^a	(Powertrain Control System Relay) ^a
13	50A Maxi	Instrument Panel Fuses: 5, 9, 13
14	—	Not Used
15	50A Maxi	Instrument Panel Fuses: 1, 7; Power Network Box Fuse 5
16	—	Not Used
17	50A Maxi	Instrument Panel Fuses: 2, 6, 11, 14, 17; Power Network Box Fuse: 11, 22; Alt. Charge Lamp
18	30A Maxi	Trailer Battery Charge
19	40A Maxi	Headlamps
20	50A Maxi	Instrument Panel Fuses: 4, 8, 12, 16
21	30A Maxi	Trailer Brake Feed
22	20A Maxi ^a	(Powertrain Control System Relay); ^a Ambulance Package Alternator; Fuel Heater
Relay 1	(Relay) ^a	(Powertrain Control System) ^a
Relay 2	Relay	Trailer Back Up Lamps
Relay 3	Relay	Horn
Relay 4	Relay	Trailer Tow and / or Dual Rear Wheel Running Lamps
Relay 5	Relay	Trailer Battery Charge

a Indicates powertrain function only.

SECTION 20A

Diesel Diagnosis—7.3L IDI Turbo Engine

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SECTION 20A

Diesel Diagnosis—7.3L IDI Turbo Engine

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SECTION 20A

Diesel Diagnosis—7.3L IDI Turbo Engine

Contents (continued)

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Diagnosis, Testing, and Adjustment—FIPL Sensor	20A-61
Fuel Injection Pump Lever FIPL Position Sensor	20A-63

Preliminary Checkout

This Section covers adjustments, diagnostics, and test procedures for the 7.3L IDI turbo diesel engine Fast Start Glow Plug System and Fuel Injection System.

Before Starting

Efficient diagnosis must take place in an organized manner with a plan or procedure which starts with the obvious and goes on to the more difficult. Eliminate all the obvious and easy-to-do items first.

Get All The Information Available

Check out all sources of information. Talk to the operator. Sometimes asking a question will cause the operator to remember something that is useful.

The following list is a set of basic questions. Get the answers to these in order to learn the true complaint and the basic problem.

Operating Conditions:

1. Did the problem occur suddenly or over a long period of time?
2. Were there any abnormal noises before the failure?
3. Was the engine under heavy or light load? Decelerating or accelerating?
4. Did the water temperature or oil pressure vary?
5. Were weather conditions a factor?
6. What type of road grade was the vehicle on when the trouble was first noticed?
7. How was the trouble first noticed (felt, heard, etc.)?
8. What was the amount of oil consumption? Fuel? Coolant? Had there been a recent change?

Preliminary Checkout

9. What was the exhaust smoke like? Light or dense? Color?
10. Does the engine have good throttle response?
11. Is deceleration normal?
12. Does the engine shut off properly?
13. Does the engine start correctly when cold?
14. Does the engine ever miss?
15. What kind of fuel is being used? Grade and source?
16. Does the engine surge at idle or wide-open throttle?
17. Is the engine subjected to periods of extended idling?
18. Has the vehicle or equipment been in an accident or collision?

Maintenance History:

1. Has the engine been serviced recently? What was done?
2. Has this complaint occurred before? If so, what was done then?
3. When were the oil and fuel filters last changed?
4. Who normally performs the maintenance and adjustments?
5. Is the maintenance schedule followed closely?
6. How is fuel obtained and stored?
7. What type service designation (CF-4) and what grade oil is used?
8. How many miles or hours has the engine operated since the last service?

Preliminary Checkout

Observed Information:

1. Is the engine clean or dirty?
2. Are the belts in good condition? Loose?
3. Is there evidence of external oil, coolant or fuel leaks?
4. Does the engine appear to have overheated?
5. Are there any make-shift repairs on the engine (loose parts, wired-on parts, etc.)?
6. How does the engine sound at idle?
7. Are any pulleys wobbling?
8. Do any parts appear to have been altered or serviced recently?
9. Are there any aftermarket or unapproved parts on the engine?
10. Have any of the lines been altered or re-routed?
11. Are oil level, coolant level and fuel level satisfactory? (If the problem concerns bearings, notice the condition of the oil.)
12. During disassembly, does the engine have unusual odors, carbon accumulations, dirt or other conditions under the rocker cover?

Test Equipment

The following test equipment (Figures 1 through 4) is required for adjusting idle speed and timing.

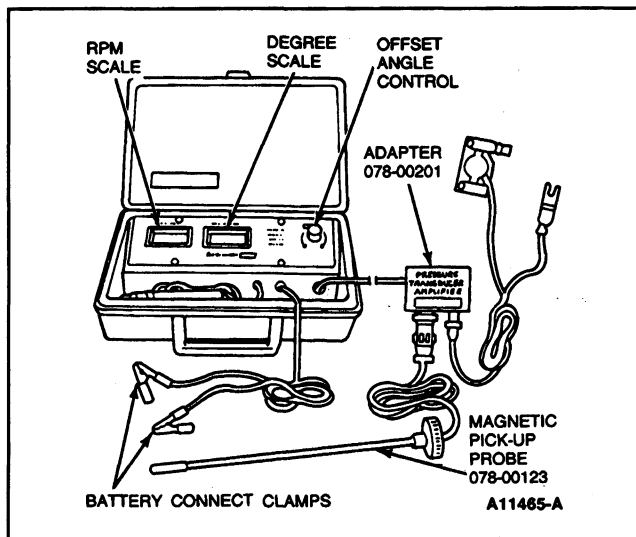


Figure 1: Rotunda 078-00200 Dynamic Timing Meter

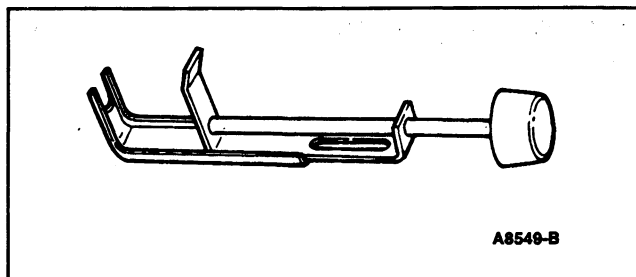


Figure 3: Throttle Control Tool D83T-9000-E

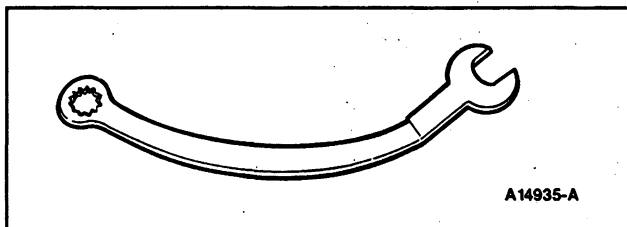


Figure 2: T83T-9000-B Injection Pump Mounting Wrench

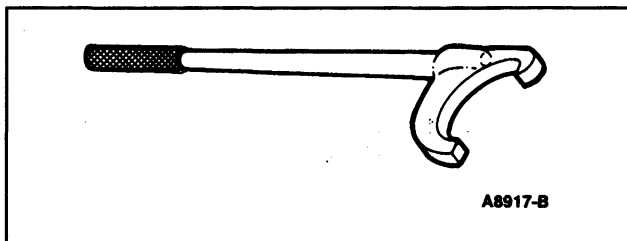


Figure 4: T83T-9000-C Injection Pump Rotating Tool

Test Equipment

The following test equipment (Figures 5 and 6) is required for performing the Engine Performance Diagnostic Procedure.

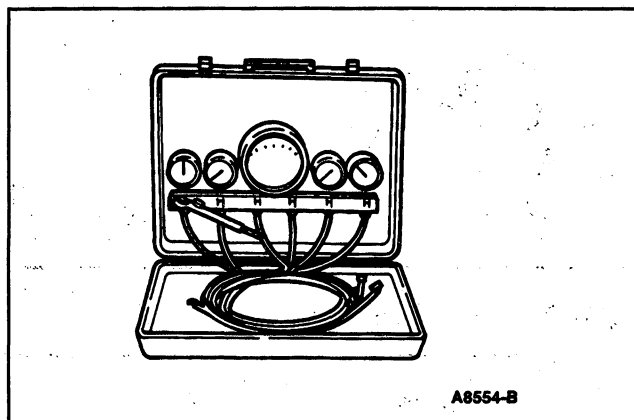


Figure 5: Rotunda 014-00761 Pressure Test Kit

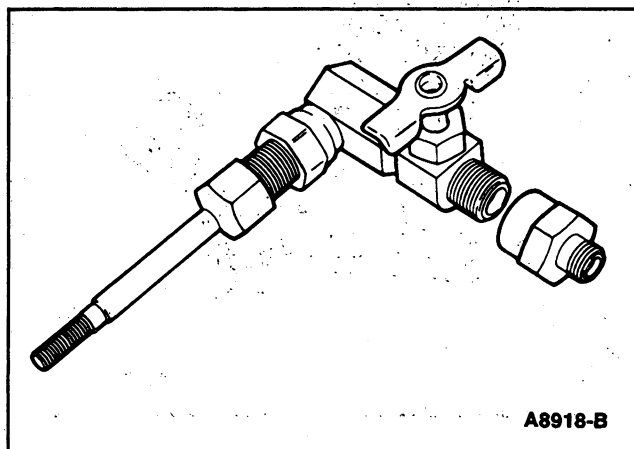


Figure 6: T83T-9000-A Fuel Transfer Pump Pressure Adapter

Test Equipment

The following test equipment (Figures 7 and 8) is required for performing the "WAIT TO START" Indicator Diagnostic Procedure and the Fast Start Glow Plug System Diagnostic Procedure.

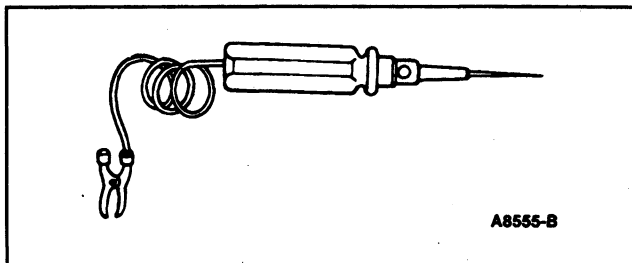


Figure 7: 12-Volt Test Lamp

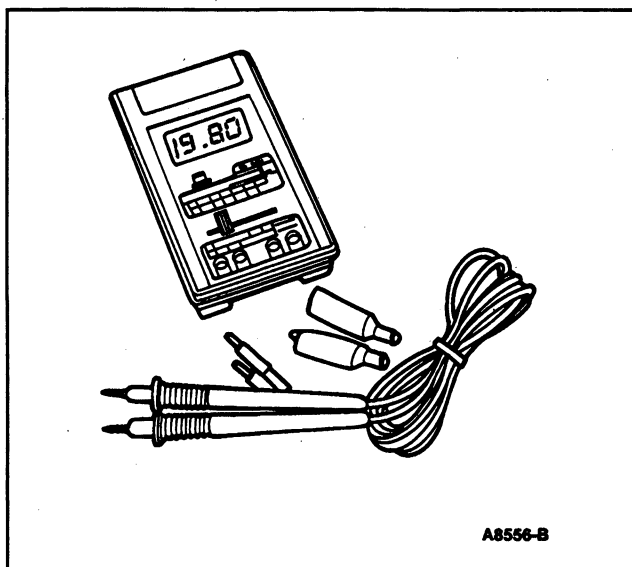


Figure 8: Rotunda 007-00001 Digital Volt-Ohmmeter

Test Equipment

The following test equipment (Figures 9 and 10) is required for injection nozzle testing and cleaning.

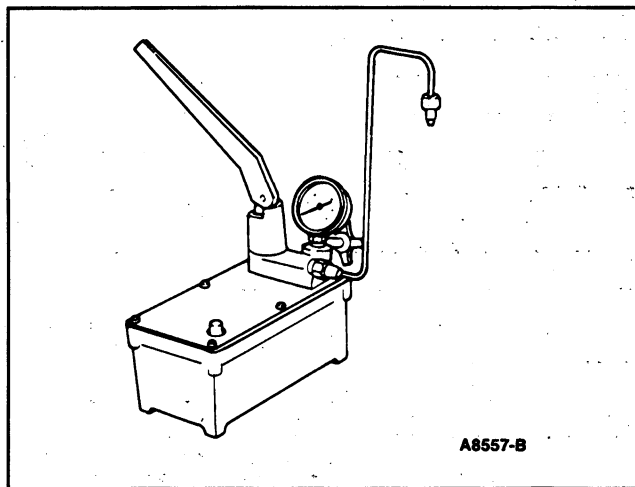


Figure 9: Nozzle Tester D83T-9000-F or equivalent

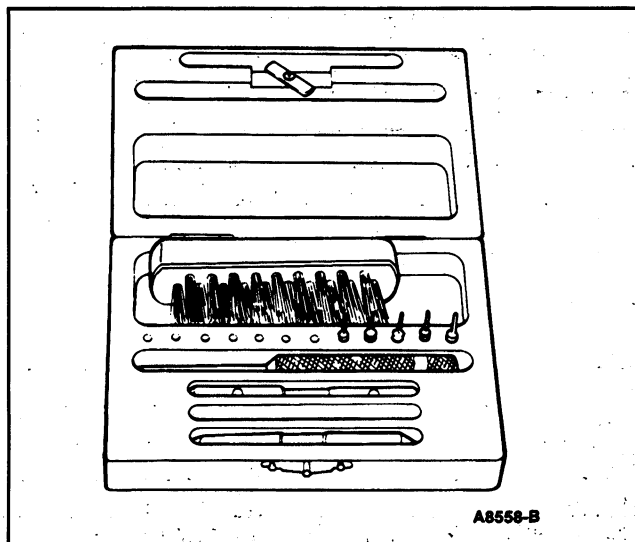


Figure 10: Nozzle Cleaning Kit D83T-9000-G or equivalent

1993 Ford Diesel Engine Performance Specifications

Engine Model	A-185, A-166
Number of Cylinders	8
Configuration	OHV V8
Bore	104.39 mm (4.11 inch)
Stroke	106.20 mm (4.18 inch)
Displacement	7.3 Liters (444 cu inch)
Crankshaft Rotation (Viewed from Flywheel End of Engine)	Counterclockwise
Compression Ratio	21.5:1
Firing Order	1-2-7-3-4-5-6-8
Idle Speed (No Load)	650 rpm \pm 50 rpm
Governor Speed (No Load)	3660 \pm 50 rpm
Governor Speed (Full Load Rated)	3000 rpm
Timing (Dynamic)	8.5 \pm 2 Degrees BTDC
Injection Pump	Stanadyne DB-2
Injection Nozzle	
Opening Pressure (New)	13,100 \pm 517 kPa (1,900 \pm 75 psi)
Opening Pressure (Minimum)	9,998 kPa (1,450 psi)
Crankcase Pressure-No Load (Maximum)	20 kPa (6 in-H ₂ O) @ 3000 rpm
Fuel Pressure (Filter Inlet)	14 kPa (2 psi) @ idle
Fuel Pressure (Filter Outlet)	7 kPa (1 psi) @ 3000 rpm
Fuel Pump Suction	20 kPa (6 in. H ₂ O) @ 3000 rpm
Fuel Return Line Pressure	14 kPa (2 psi) @ 3000 rpm
Valve Lifter	0 Valve Lash
Engine Lube Oil Pressure Low Idle, Minimum	69 kPa (10 psi)
(Engine at Operating Temperature)	276-482 kPa (40-70 psi)
Crankcase Capacity (Without Filter)	8.5 L (9 qt.)
Crankcase Capacity (With Filter)	9.5 L (10 qt.)
Thermostat Opening Temperature	89°C (192°F)

* Manual transmission in NEUTRAL position. Automatic transmission in DRIVE position.

Idle Speed Setting Procedures

Curb Idle Speed Adjustment

1. Place transmission in NEUTRAL or PARK.
2. Bring engine up to normal operating temperature.
3. Idle speed is measured with manual transmission in NEUTRAL and automatic transmission in DRIVE.
4. Make sure that low idle adjusting screw is against the stop. If not, correct vehicle linkage.
5. Check low idle speed, using Rotunda 055-00108 or equivalent. Low idle speed is specified on the Vehicle Emissions Control Information (VECI) decal. Adjust to specification using idle speed adjusting screw (Figure 11).
6. Place transmission in NEUTRAL or PARK. Rev engine momentarily. Place transmission in specified gear and check low idle rpm. Adjust again if necessary.

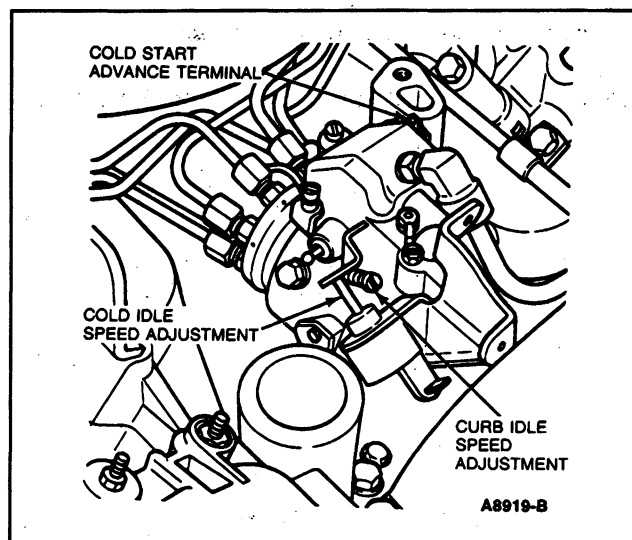


Figure 11: Idle Speed Adjusting Screw

Idle Speed Setting Procedures

Fast Idle Adjustment

At Cold Idle Solenoid:

1. Place transmission in NEUTRAL or PARK.
2. Start engine and bring up to normal operating temperature.
3. Disconnect fast idle solenoid from wiring harness.
4. Apply battery voltage to solenoid to activate it.
5. Rev engine momentarily to set solenoid to activate it.
6. Check fast idle speed setting. Fast idle rpm should be 825 ± 25 . Adjust to specification by turning solenoid plunger in or out (Figure 11).
7. Rev engine momentarily and check fast idle rpm. Adjust as necessary.
8. Remove battery voltage from solenoid connector and connect to wiring harness.

Setting Injection Timing—Static Timing

1. Remove fast idle bracket and solenoid from injection pump.
2. Break torque (keeping nuts snug) on three nuts attaching injection pump to pump mounting adapter using Injection Pump Mounting Wrench T83T-9000-B (Figure 2).
3. Install Injection Pump Rotating Tool T83T-9000-C (Figure 4) on front of pump and rotate injection pump to align timing mark on injection pump mounting flange with timing mark on pump mounting adapter, to within $\pm 0.75\text{mm}$ (0.030 inches).
4. Remove rotating tool and tighten nuts to specification. Visually check timing to verify that timing marks are aligned (Figure 12).
5. Install fast idle bracket and solenoid and tighten bolts to specification.

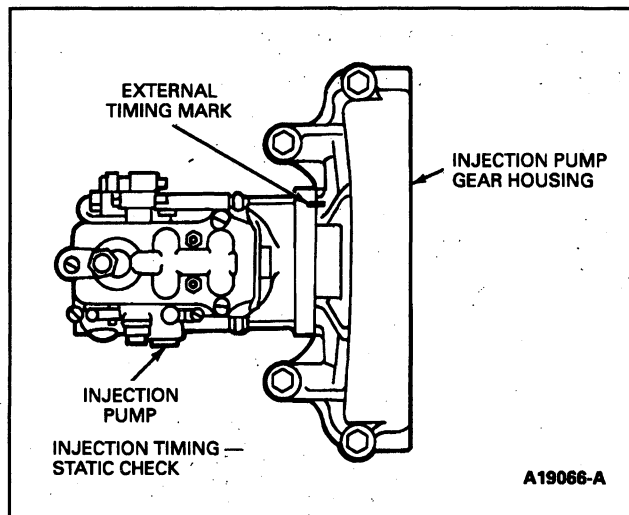


Figure 12: Injection Pump Timing Marks

Setting Injection Timing—Dynamic Timing

NOTE: When checking or setting dynamic injection timing on the 7.3L IDI turbo diesel engine it is mandatory that the engine be stabilized at normal operating temperature of 89°C-100°C (192°F-212°F). This temperature is needed to ensure proper fuel ignition in the precombustion chambers.

1. Bring engine up to normal operating temperature.

NOTE: To prevent incorrect readings, make sure that vibration damper is clean and free of foreign debris and rust scale. If required, sand the area to remove rust and apply a light coat of paint to the area.

2. Stop engine and install Dynamic Timing Meter, Rotunda 078-00200 or equivalent, by placing magnetic pickup in timing pointer probe hole (Figure 13). Insert pickup until it almost touches vibration damper.
3. Attach clamp from Timing Meter Adapter Rotunda 078-00201 or equivalent to the line pressure sensor on No. 1 injector nozzle (F-Series) and connect to timing meter (Figure 14).

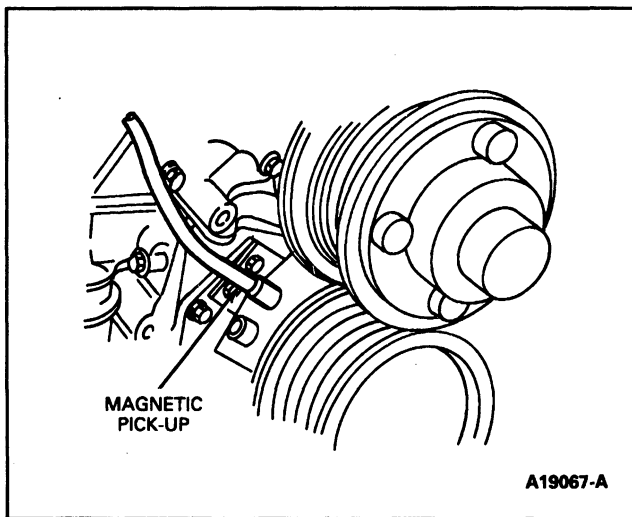


Figure 13: Magnetic Pickup—Dynamic Timing

NOTE: Make sure that all wire leads are located away from the front accessory drive belts.

4. Connect dynamic timing meter to battery and dial in minus 20 degrees offset on meter. Disconnect cold start advance solenoid connector from solenoid terminal (Figure 11).

NOTE: Activating cold start advance solenoid can result in engine speed increase. Adjust throttle control to attain 2000 rpm, if required.

5. With transmission in NEUTRAL and rear wheels raised off the ground, start engine. Using Idle Speed Adjusting Tool D83T-9000-E or equivalent, set engine speed to 2000 rpm with no accessory load. Observe injection timing on dynamic timing meter. Injection timing should be 8.5 degrees BTDC at 2000 rpm.
6. Apply battery voltage to cold start advance solenoid terminal to activate it.

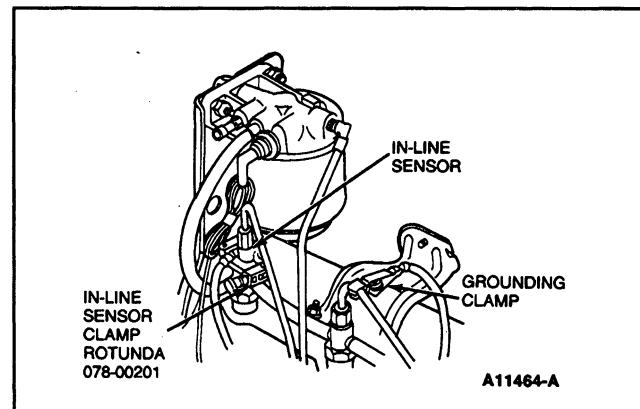


Figure 14: Luminosity Probe—Dynamic Timing

Setting Injection Timing—Dynamic Timing

7. Check timing at 2000 rpm. The timing should be advanced at least 1 degree before the timing obtained in Step 5. If the advance is less than 1 degree, replace fuel injection pump top cover assembly.
8. If dynamic timing is not within ± 2 degrees of specification, adjustment of pump timing is necessary.
9. Turn engine off. Note timing mark alignment. Remove fast idle bracket and solenoid from injection pump. Break torque (keeping nuts snug) on nuts attaching injection pump to pump mounting adapter with Injection Pump Mounting Wrench T83T-9000-B (Figure 2).
10. Install Injection Pump Rotating Tool, T83T-9000-C (Figure 4), on front of pump. Rotate clockwise (when viewed from front of engine) to retard, and counterclockwise to advance timing, by lightly tapping tool with a rubber mallet. Two degrees of dynamic timing is approximately 0.75mm (0.030 inch) of timing mark movement.
11. Remove rotating tool and tighten nuts to specification. Start engine and recheck timing.
12. Repeat Steps 9, 10 and 11 as necessary, to set timing to ± 1 degree of specification.
13. Turn engine off. Remove dynamic timing components. Install fast idle bracket and solenoid and tighten bolts to specification.

System Description

This portion of this Section contains a brief description of the 7.3L IDI turbo diesel engine "WAIT TO START" Indicator System, Solid-State Glow Plug System and Fuel System. It also contains detailed diagnostic procedures for these systems.

The diagnostic procedures are broken into two parts. The first part is Symptom Analysis. This Section should be consulted first, as it will provide direction to perform a specific service or to a specific diagnostic procedure.

The second part contains the "WAIT TO START" Indicator, Solid-State Glow Plug System, Engine Performance diagnostic procedures, Fuel System Air Leak Diagnosis and Nozzle Testing. At the beginning of each of these procedures, there is an explanation of how to use that procedure. Read this explanation before performing the tests.

Warning Indicators

“Wait To Start” Indicator

NOTE: If the ignition switch is left in the ON position for an extended period of time or the engine is not started within the two minute cycling time, the glow plug system must be reset by turning the ignition switch to OFF position.

The “WAIT TO START” indicator comes on when the ignition switch is turned to the RUN position, and the engine is below normal operating temperature. It will remain lit for 4 to 20 seconds, depending on engine temperature. If engine is at or above normal operating temperature the indicator will not turn on.

Fuel Filter Restriction Warning Indicator

The 7.3L IDI turbo diesel is equipped with a fuel filter restriction sensor. A restriction indicator is located in the instrument cluster to alert the operator.

If the indicator comes on during normal engine operation, replace the filter as soon as possible.

“Water In Fuel” Warning Indicator

The “WATER IN FUEL” warning indicator should turn on when the ignition switch is in the START position to indicate proper indicator and sensor function. The indicator will come on if the fuel filter / water separator has a significant amount of water in it. If the indicator comes on during normal engine operation, drain the fuel bowl in the filter as soon as possible. Water in the fuel could cause extensive damage to the fuel injection system.

Solid-State Glow Plug System

The Solid-State Glow Plug System consists of the glow plug controller, the glow plug harness assembly and glow plugs (Figure 15).

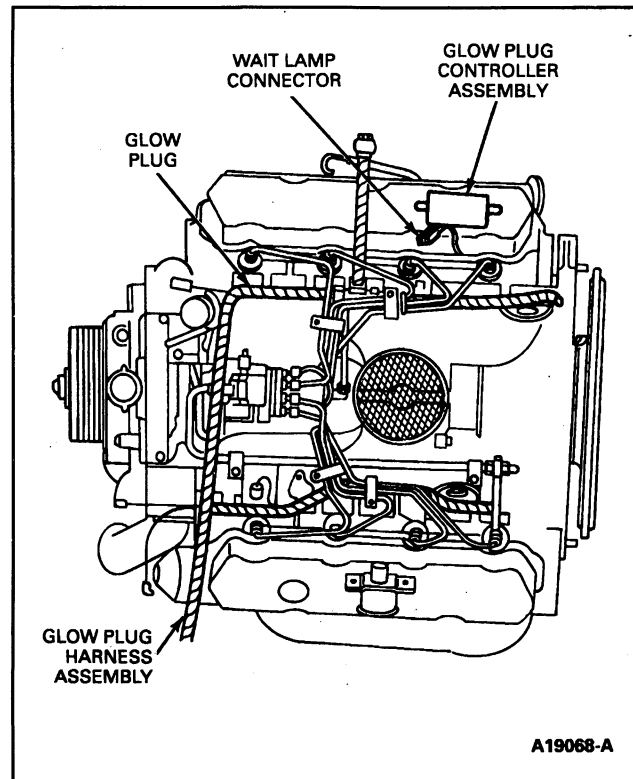


Figure 15: Solid State Glow Plug Control System

The system determines the glow plug temperature by electronically measuring the resistance of the glow plugs. It then maintains this temperature regardless of ambient temperatures.

The system is actuated when the ignition switch is turned to the RUN position. The "WAIT TO START" indicator lights until the glow plugs reach the proper temperature. The indicator goes out and the engine can be started.

The afterglow operation of the glow plugs continues after the "WAIT TO START" indicator turns off. The glow plugs cycle on and off for a period of time. This helps to reduce white smoke after engine start-up.

The glow plug system can be recycled by turning the ignition off and on. This immediately restarts the glow plug cycle. The engine can be started as soon as the "WAIT TO START" indicator goes off.

Solid-State Glow Plug System

Glow Plug Controller

The power relay is mounted on top of the solid-state controller circuit board. The complete assembly is mounted on the right rocker cover (Figure 16).

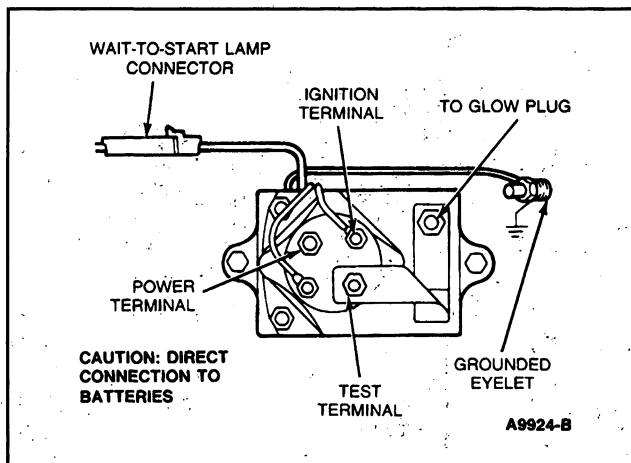


Figure 16: Solid-State Glow Plug Controller

Glow Plugs

The system uses positive temperature coefficient (PTC) glow plugs. The resistance of the glow plugs changes as the temperature rises. The glow plugs use bullet-type terminals (Figure 17).

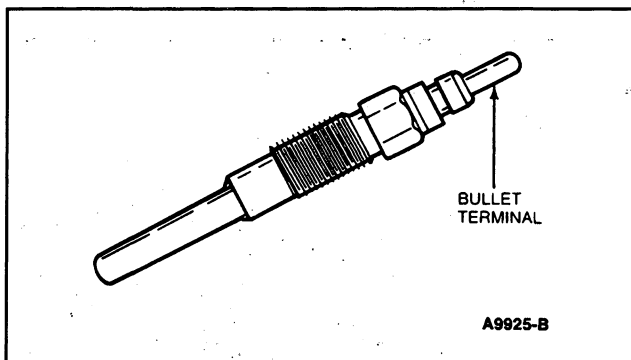


Figure 17: Glow Plugs

Solid-State Glow Plug System

Wiring Schematic

Use the electrical wiring schematic (Figure 18) when diagnosing the glow plug system.

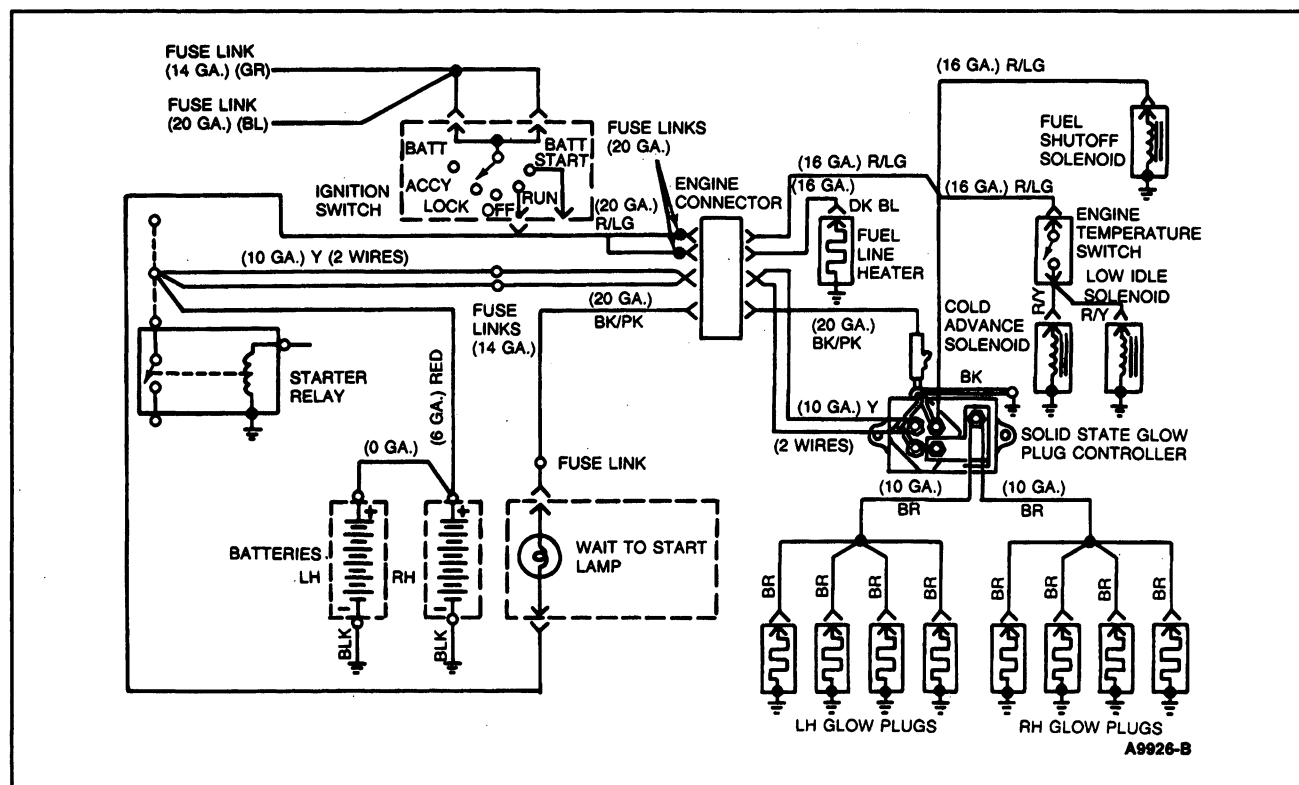


Figure 18: Wiring Schematic

Fuel System Description

Figure 19 shows a schematic of the fuel supply and return lines. Fuel from the tank is routed to the fuel supply pump which pumps fuel through a combination fuel filter, heater system and water separator. The filter header contains a continuous vent (orifice bleed-off system) which aids starting by eliminating the need to manually prime the fuel filter. A vacuum switch is incorporated into the fuel filter header which will activate a light on the instrument panel indicating the need for filter replacement. The water separator portion of the filter assembly has a probe which will activate an instrument panel light when the filter requires draining at the water and sediment drain located on the bottom of the assembly.

Fuel enters the inlet of the injection pump and is delivered under high pressure through injection nozzles into the engine cylinders for combustion. On each nozzle is a fuel return fitting that returns excess fuel to the fuel tank. Excess fuel from the injection pump and each injection nozzle are collected in bleed-off lines and returned to the fuel tank.

The fuel return crossover line on the 7.3L IDI turbo diesel engine runs from the #5 injector tee to #6 injector tee, in front of the air chamber.

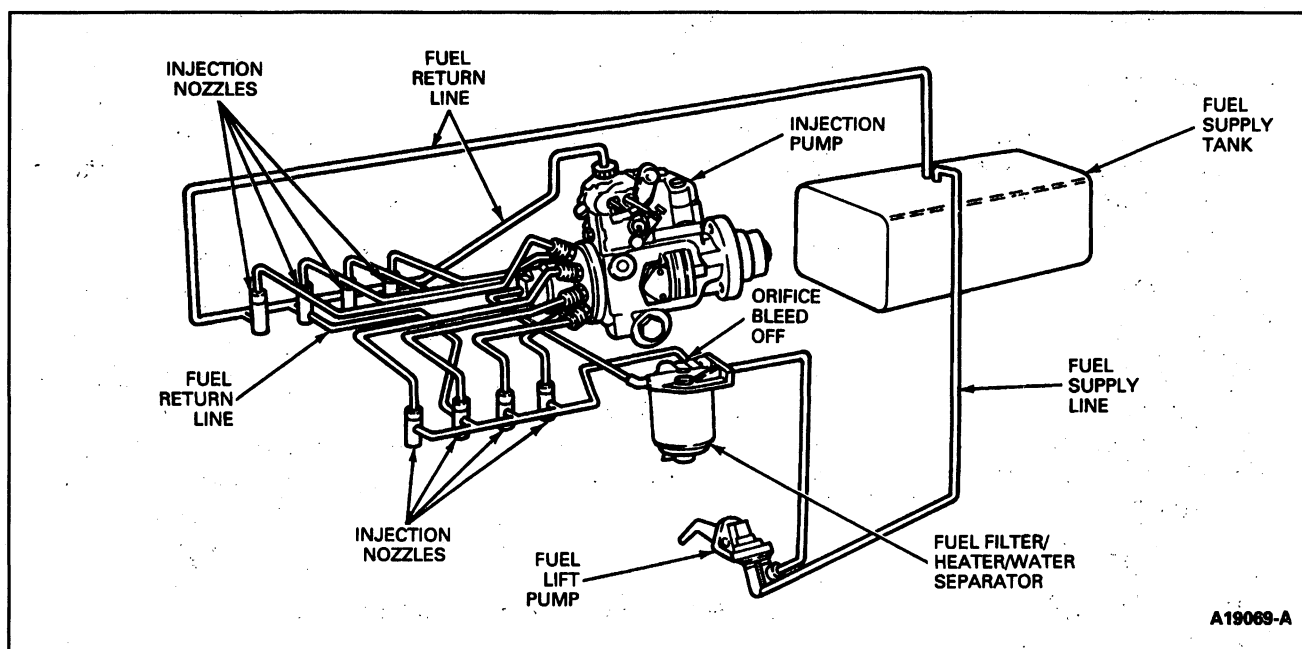


Figure 19: Fuel System Schematic

Symptom Analysis

Consult the Symptom Analysis Diagnostic Procedures first. These will indicate a service to be performed or provide direction to either the Fast Start Glow Plug System Diagnostic Procedure or the Engine Performance Diagnostic Procedure.

If the GLOW PLUG indicator is suspected of being faulty, go directly to the Glow Plug diagnostic procedure before performing the Glow Plug System Diagnostic Procedure.

If the problem is loss of power and / or increased fuel consumption, go directly to the Engine Performance Diagnostic Procedure.

Evaluating Normal Diesel Engine Exhaust Smoke

The following is a description of what is normal and expected exhaust smoke for a vehicle with a diesel engine. Diesel exhaust smoke can be classified into two categories according to the color of the smoke.

NOTE: Chassis fuel system air leaks may also cause continuous heavy blue-white smoke.

The first category is blue-white smoke.

- Blue-white smoke may be observed at engine start-up whether the engine is up to operating temperatures or not. This start-up smoke will be observed at all ambient temperatures and should last no longer than a minute after the vehicle is driven.
- When ambient temperature is below 10°C (50°F), blue-white smoke can return after the engine warm-up due to extended idling. This is due to the combustion chambers cooling down during periods of extended idling time.

Heavy blue-white smoke will also occur when the engine is operated at wide-open throttle (accelerator pedal to the floor) with the transmission in NEUTRAL or with a lightly loaded vehicle in any transmission gear setting. The smoke is a normal characteristic for a diesel engine with a light min.-max. governor spring in the fuel injection pump. This results in the following characteristics due to the engine operating above its rated speed (3300 rpm) in a no-load or lightly loaded condition:

- Heavy blue-white smoke.
- Fuel injection pump governor hunting resulting in high speed engine rpm surging.
- Engine sputtering or misfiring.

The conditions can be eliminated by operating the engine at or below its maximum full load rated speed of 3000 rpm.

The second category of diesel exhaust smoke is black smoke. Black smoke occurs whenever the engine is working hard. The engine works hard when it is going up a steep grade, pulling a trailer, carrying a heavy load, or during acceleration. More black smoke will be observed when operating the vehicle at higher altitudes. If black smoke is observed while the engine is idling (at low altitude) or under normal driving conditions, the problem should be diagnosed as soon as possible.

Symptom Analysis

Symptom	Test/Procedure
Engine Cranks But Will Not Start (Cold)	Pinpoint Test A
Engine Cranks But Will Not Start (Normal Operating Temperature)	Pinpoint Test B
Engine Quits, Stalls or Stumbles	Pinpoint Test C
Engine Misses	Pinpoint Test D
Engine Knocks	Pinpoint Test E
Low Oil Pressure with Proper Oil Level	Pinpoint Test F
Blue/White Smoke (Engine at Normal Operating Temperature)	Pinpoint Test G
Excessive Black Smoke	Pinpoint Test H
"Wait-To-Start" Indicator Testing	Pinpoint Test J
Glow Plug Testing	Pinpoint Test K
Fuel System Air Leak Diagnosis	Pinpoint Test L
Loss of Power	Go to Engine Performance Diagnostic Procedure
Increased Fuel Consumption	Go to Engine Performance Diagnostic Procedure

Engine Cranks But Will Not Start (Cold)

Pinpoint Test

A

TEST STEP		RESULT	ACTION TO TAKE
A0	STARTING PROCEDURE		
	<p>NOTE: If the ignition key is left in the ON position for an extended period of time or the engine is not started within the two minute cycling time, the glow plug system must be reset by turning the ignition key to OFF position.</p> <ul style="list-style-type: none"> ● Check and follow correct starting procedure on vehicle visor. ● Does engine start correctly? 	<p>Yes</p> <p>No</p>	<p>▶ RETURN vehicle to customer.</p> <p>▶ GO to A1.</p>
A1	GLOW PLUG MODULE RELAY		
	<ul style="list-style-type: none"> ● Open hood. ● Listen for glow plug module relay click when ignition switch is turned to ON position. ● Does glow plug module relay click? 	<p>Yes</p> <p>No</p>	<p>▶ GO to A2.</p> <p>▶ GO to Glow Plug System Diagnostic Procedure.</p>
A2	FUEL FLOW CHECK		
	<ul style="list-style-type: none"> ● Loosen one injection nozzle line nut (1/2 to one turn) while cranking engine. ● Does fuel discharge? 	<p>Yes</p> <p>No</p>	<p>▶ GO to Glow Plug System Diagnostic Procedure.</p> <p>▶ GO to A3.</p>
A3	ENERGIZE TO RUN SOLENOID (ETR)		
	<ul style="list-style-type: none"> ● Check voltage at ETR solenoid (terminal located at front of injection pump) while cranking engine. Voltage must be at least 9 volts. ● Check solenoid terminal for dirt / corrosion and loose / broken electrical connection. ● Is ETR solenoid voltage present and electrical connection OK? 	<p>Yes</p> <p>No</p>	<p>▶ GO to A4.</p> <p>▶ REFER to Service Manual, Section 14-00. REPEAT Test Step A3.</p>
A4	CHECK COLD IDLE SPEED / ADVANCE		
	<ul style="list-style-type: none"> ● Check voltage at cold advance solenoid (terminal located at left rear of injection pump) while cranking engine. Voltage must be at least 9 volts. ● If no voltage is present, verify switching function of temperature sensing switch located behind thermostat housing. ● Is a fault indicated? 	<p>Yes</p> <p>No</p>	<p>▶ REFER to Service Manual, Section 14-00. REPEAT Test Step A4.</p> <p>▶ GO to Engine Performance Diagnostic Procedure.</p>

Engine Cranks But Will Not Start (Normal Operating Temperature)

Pinpoint Test

B

TEST STEP		RESULT	ACTION TO TAKE
B0	STARTING PROCEDURE		
	<ul style="list-style-type: none"> Check and follow correct starting procedure on vehicle visor. Does engine start correctly? 	Yes	RETURN vehicle to customer.
		No	GO to B1 .
B1	FUEL FLOW CHECK		
	<ul style="list-style-type: none"> Loosen one injection nozzle line nut (1/2 to one turn) while cranking engine. Does fuel discharge? 	Yes	GO to Engine Performance Diagnostic Procedure.
		No	GO to B2 .
B2	ENERGIZE-TO-RUN SOLENOID (ETR)		
	<ul style="list-style-type: none"> With ignition switch in the ON position, check voltage at ETR solenoid (terminal at front of injection pump). Voltage must be at least 9 volts. Check solenoid terminal for dirt / corrosion and loose / broken electrical connection. Is ETR solenoid voltage present and electrical connection OK? 	Yes	GO to Engine Performance Diagnostic Procedure.
		No	REFER to Service Manual, Section 14-00. REPEAT Test Step B2 .

Engine Quits, Stalls or Stumbles

Pinpoint Test

C

TEST STEP		RESULT	ACTION TO TAKE
C0	IDLE SPEED		
	<ul style="list-style-type: none"> Perform Test Step EPC15 in the Engine Performance Diagnostic Procedure. Is idle speed within specifications? 	Yes No	GO to C1 . ADJUST idle speed as outlined under Adjustments.
C1	ENERGIZE-TO-RUN SOLENOID (ETR)		
	<ul style="list-style-type: none"> Check ETR solenoid (terminal located at left front of injection pump) for dirt / corrosion and loose / broken electrical connection. While cranking, voltage must be at least 9 volts. Is ETR solenoid voltage present and electrical connection OK? 	Yes No	GO to C2 or C3 as required. CLEAN, SERVICE or REPLACE terminal connection. REFER to Service Manual, Section 14-00. REPEAT Test Step C1 .
C2	COLD ADVANCE SYSTEM (COLD ENGINE)		
	<ul style="list-style-type: none"> Check voltage at cold advance solenoid (terminal located at left rear of injection pump) while cranking engine. Voltage must be at least 9 volts. If no voltage is present, verify switching function of temperature sensing switch located behind thermostat housing. Is a fault indicated? 	Yes No	REFER to Service Manual, Section 14-00. REPEAT Test Step C2 . GO to Engine Performance Diagnostic Procedure.
C3	COLD ADVANCE SYSTEM (HOT ENGINE)		
	<ul style="list-style-type: none"> Check for voltage at cold advance solenoid (terminal located at left rear of injection pump) while cranking engine. No voltage should be present. Is voltage present at solenoid? 	Yes No	REPLACE temperature sensing switch. REPEAT Test Step C3 . GO to Engine Performance Diagnostic Procedure.

Engine Misses	Pinpoint Test	D
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TEST STEP		RESULT	ACTION TO TAKE
D0	DETERMINE WHEN MISS OCCURS		
	<ul style="list-style-type: none"> Engine will miss when cold if one or more glow plugs are not heating. Does engine miss only when cold? 	Yes	REFER to Glow Plug System Diagnostic Procedure.
		No	GO to D1 .
D1	ISOLATE MISS		
	<ul style="list-style-type: none"> Loosen each injection nozzle line nut (one at a time) while running engine. Refer to Injection Nozzle Testing as outlined. Is miss isolated to a specific cylinder(s)? 	Yes	GO to D2 .
		No	GO to Engine Performance Diagnostic Procedure.
D2	CHECK NOZZLE FUEL DELIVERY		
	<ul style="list-style-type: none"> Check injection nozzle fuel line(s) for kinks or restrictions as described in Service Manual, Section 03-01D. Perform injection nozzle test as described under Injection Nozzle Testing as outlined. Are nozzle(s) and lines OK? 	Yes	GO to D3 .
		No	REPLACE damaged line(s) as outlined in Service Manual, Section 03-01D. REPLACE nozzle(s) as outlined under Injection Nozzle Testing.
D3	CYLINDER COMPRESSION CHECK		
	<ul style="list-style-type: none"> Perform cylinder compression test as described in Service Manual, Section 03-01D. Is cylinder compression OK? 	Yes	GO to Engine Performance Diagnostic Procedure.
		No	GO to D4 .
D4	CHECK CRANKCASE PRESSURE		
	<ul style="list-style-type: none"> Perform Engine Performance Diagnostic Procedure Test Step EPC19. Is crankcase pressure within specifications? 	Yes	SERVICE or REPLACE valve train as outlined in Service Manual, Section 03-01D.
		No	OVERHAUL power cylinder as outlined in Service Manual, Section 03-01D.

Engine Knocks**Pinpoint
Test****E**

TEST STEP		RESULT	ACTION TO TAKE
E0	BELT-DRIVEN ACCESSORIES		
	<ul style="list-style-type: none"> Check engine accessory drive components for proper operation. Are accessory drive components OK? 	Yes No	GO to E1 . SERVICE or REPLACE as necessary. REFER to specific accessory Service Manual Section.
E1	ENGINE COOLANT TEMPERATURE		
	<ul style="list-style-type: none"> Verify engine is not overheating. Is engine overheating? 	Yes No	REFER to Service Manual, Section 03-03. GO to E2 .
E2	ISOLATE ENGINE KNOCK		
	<ul style="list-style-type: none"> Loosen each injection nozzle line nut (one at a time) while engine is running. Refer to Injection Nozzle Testing. Is engine knock isolated to a specific cylinder? 	Yes No	GO to E3 . GO to Engine Performance Diagnostic Procedure.
E3	CHECK NOZZLE FUEL DELIVERY		
	<ul style="list-style-type: none"> Check injection nozzle fuel line(s) for kinks or restrictions as described in Service Manual Section 03-01D. Perform injection nozzle test as outlined under Injection Nozzle Testing. Are nozzle(s) and lines OK? 	Yes No	GO to Engine Performance Diagnostic Procedure. REPLACE damaged line(s) as outlined in Service Manual, Section 03-01D. REPLACE nozzle(s) as described under Injection Nozzle Testing.

Low Oil Pressure With Proper Oil Level

Pinpoint Test

F

TEST STEP		RESULT	ACTION TO TAKE
F0	OIL PRESSURE TRANSDUCER		
	<ul style="list-style-type: none"> Verify accuracy of oil pressure transducer. Use Adapter 5633 with Pressure Test Kit 014-00761 or equivalent. Refer to Pressure Test Kit Hookup illustration as outlined under Test Equipment. Is transducer accurate? 	Yes No	► GO to F1 . ► REPLACE transducer. REPEAT Test Step F0 .
F1	CHANGE ENGINE OIL AND FILTER		
	<ul style="list-style-type: none"> Change engine oil and filter and run engine until normal operating temperature is reached. Check oil pressure reading. Is oil pressure reading within specifications? 	Yes No	► RETURN vehicle to customer. ► SERVICE or REPLACE lubrication system components as necessary. REFER to Service Manual, Section 03-01D.

Blue/White Smoke (Engine At Normal Operating Temperature)

Pinpoint Test

G

TEST STEP		RESULT	ACTION TO TAKE
G0	ENGINE TEMPERATURE		
	NOTE: Refer to Symptom Analysis. <ul style="list-style-type: none"> Verify that engine stabilizes in normal operating range. Is engine operating temperature normal? 	Yes No	GO to G2 . GO to G1 .
G1	THERMOSTAT OPERATION		
	<ul style="list-style-type: none"> Remove thermostat. Refer to Service Manual, Section 03-01D. Test thermostat for proper operation. Refer to Service Manual, Section 03-01D. Is thermostat operating properly? 	Yes No	REPLACE thermostat housing with integral air bleed check valve. REPEAT Test Step G0 . REPLACE thermostat. (REFER to Service Manual, Section 03-01D). REPEAT Test Step G0 .
G2	EXCESSIVE OIL LEVEL		
	<ul style="list-style-type: none"> Check engine oil level indicator for excessive oil fill. Is oil fill level within specifications? 	Yes No	GO to G3 . DRAIN excess oil from oil pan. If concern still exists, GO to G3 .
G3	FUEL RETURN		
	<ul style="list-style-type: none"> Perform fuel return pressure test as outlined in Test Step EPC8 of the Engine Performance Diagnostic Procedure. Is a fault indicated? 	Yes No	SERVICE or REPLACE fuel return line(s) as necessary. (Refer to Service Manual, Section 10-01B.) REPEAT Step G3 . PERFORM entire Engine Performance Diagnostic Procedure.

Excessive Black Smoke	Pinpoint Test	H
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TEST STEP		RESULT	ACTION TO TAKE
H0	VERIFY OIL LEVEL		
NOTE: Refer to Symptom Analysis. <ul style="list-style-type: none"> Verify under what conditions black smoke occurs. 		Light load and/or low altitude	GO to H1 . NOTE: For warranty claim approval, Engine Performance Chart must be filled out for the following steps: EPC3, EPC14, EPC18, EPC19.
		Under heavy load	Normal condition when going up steep grades, pulling a trailer, maximum load, maximum acceleration or at high altitudes.
H1	EXHAUST SYSTEM CONDITION		
<ul style="list-style-type: none"> Complete Test Step EPC3 of Engine Performance Diagnostic Procedure, and record symptom description and results on Engine Performance Chart. Is exhaust system damaged or restricted? 		Yes	SERVICE or REPLACE exhaust system as necessary. (REFER to Service Manual, Section 09-00.) If concern still exists, GO to H2 .
		No	GO to H2 .
H2	CHECK AIR CLEANER RESTRICTION		
<ul style="list-style-type: none"> Complete Test Step EPC14 of Engine Performance Diagnostic Procedure and record results on Engine Performance Chart. Is a fault indicated? 		Yes	REPLACE air filter element and/or SERVICE system. REPEAT Test Step H2 .
		No	GO to H3 .
H3	INJECTION PUMP TIMING		
<ul style="list-style-type: none"> Complete Test Step EPC16 of Engine Performance Diagnostic Procedure and record results on Engine Performance Chart. Is injection pump timing within specifications? 		Yes	GO to H4 .
		No	ADJUST timing. (REFER to Adjustments as outlined.) If concern still exists, GO to H4 .

Excessive Black Smoke**Pinpoint
Test****H**

TEST STEP		RESULT	ACTION TO TAKE
H4	INJECTION NOZZLES		
<ul style="list-style-type: none"> Complete Test Step EPC18 of Engine Performance Diagnostic Procedure and record results on Engine Performance Chart. Is a fault indicated? 		Yes	<ul style="list-style-type: none"> REPLACE damaged injection nozzle fuel inlet lines (REFER to Service Manual, Section 03-01D). REPLACE nozzles as outlined in this Section, and Service Manual, Section 03-01D. If concern still exists, REPLACE injection pump as outlined in Service Manual, Section 03-01D.
		No	<ul style="list-style-type: none"> REPLACE injection pump as outlined in Service Manual, Section 03-01D.

Solid-State Glow Plug System Diagnostic Procedure

Perform the Glow Plug System Basic Diagnostic Test (hereafter referred to as Basic Test) first. If the vehicle passes the Basic Test without running any Pinpoint Tests, the Glow Plug system is OK and the vehicle's problem exists somewhere other than the Glow Plug System. However, if a step of the Basic Test fails, run only the Pinpoint Test specified by the failed step.

Refer to Figure 20 for test lamp connections and Glow Plug System wiring harness test points referred to in the Basic Test and the Pinpoint Tests. Perform only those services specified by the Pinpoint Tests.

Operation of the Glow Plug System is completely automatic. If after completing a specific Pinpoint Test it is determined that a component must be replaced, the glow plugs should be disconnected until system has been re-checked by repeating the Basic Test to make sure the Glow Plug System works properly.

A Fast Start Glow Plug System Troubleshooting Chart is available for use by technicians. The technician can use it as a check list while performing tests and diagnostic procedures.

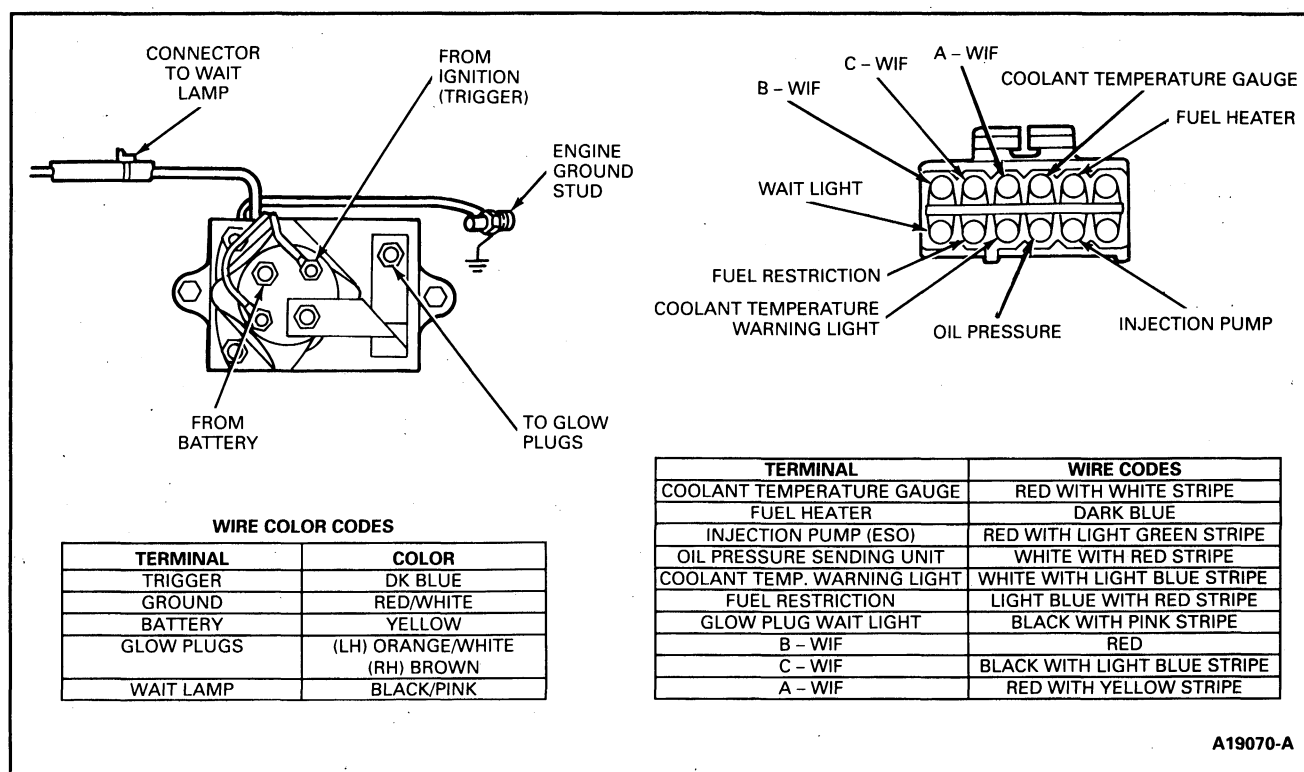


Figure 20: Glow Plug System Diagnostic Test Points

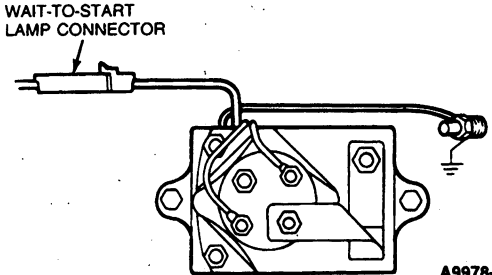
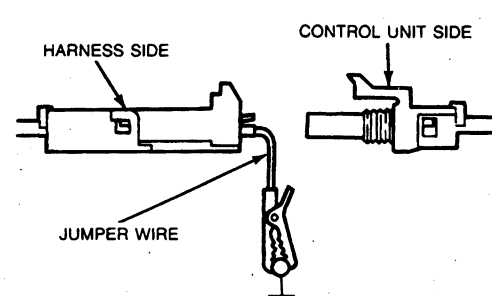
Glow Plug Pinpoint Testing

The following is a series of Pinpoint Tests that can be used to diagnose the glow plug system.

CAUTION

Never bypass the timed pulse function of the glow plug system. A constant 12 volt current to the glow plugs will cause them to overheat and fail within seconds, possibly resulting in severe engine damage.

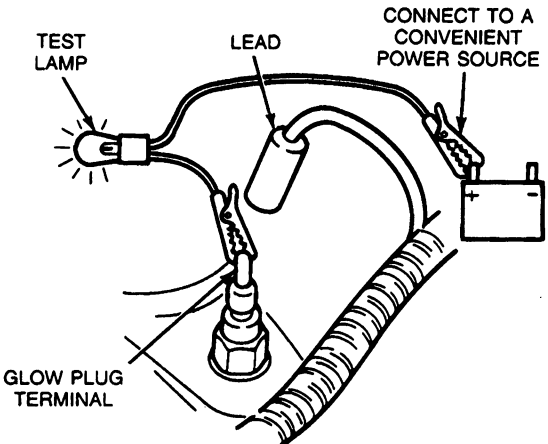
'Wait-To-Start' Indicator Testing**Pinpoint Test****J**

TEST STEP		RESULT	ACTION TO TAKE
J1	"WAIT-TO-START" INDICATOR STAYS ON <ul style="list-style-type: none"> ● Disconnect the "WAIT-TO-START" indicator connector at control unit. ● Turn ignition switch to ON position.  <p>Is the indicator ON?</p>	<p>Yes</p> <p>No</p>	<p>▶ SERVICE wiring to indicator.</p> <p>▶ DISCONNECT power at both batteries. REPLACE control unit.</p>
J2	"WAIT-TO-START" INDICATOR DOES NOT GO ON <ul style="list-style-type: none"> ● Disconnect the "WAIT-TO-START" indicator connector at control unit. ● Connect jumper wire from harness side to ground. ● Turn ignition switch to ON position.  <p>Is the indicator ON?</p>	<p>Yes</p> <p>No</p>	<p>▶ GO to Hard Starting Checks.</p> <p>▶ REPLACE bulb or SERVICE wiring.</p>

Glow Plug Testing

Pinpoint Test

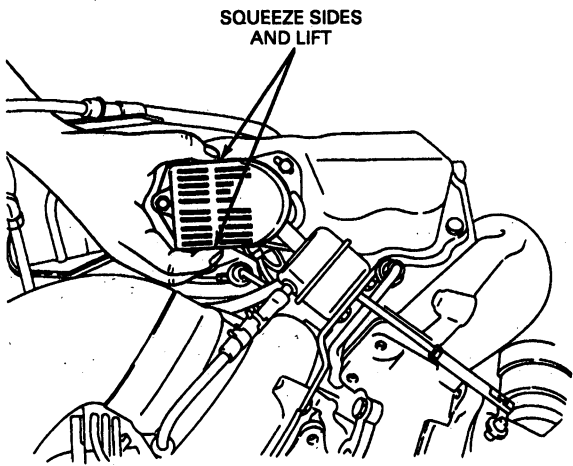
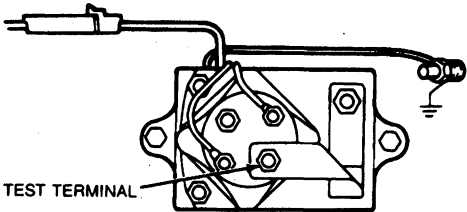
K

TEST STEP		RESULT	ACTION TO TAKE
K1	CHECK GLOW PLUGS		
	<ul style="list-style-type: none"> Ignition switch in OFF position and leads removed from glow plugs. Check continuity between glow plug terminal and a power source with glow plugs installed in engine.  <p style="text-align: right;">A9970-B</p> <ul style="list-style-type: none"> Do glow plugs have continuity? 	<p>Yes</p> <p>No</p>	<p>▶ GO to K2.</p> <p>▶ REPLACE plug(s). GO to K2.</p>

Glow Plug Testing

Pinpoint Test

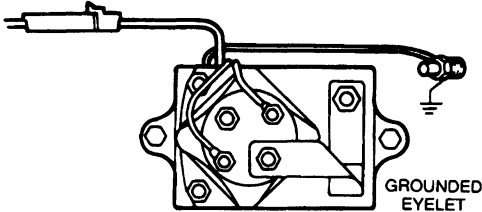
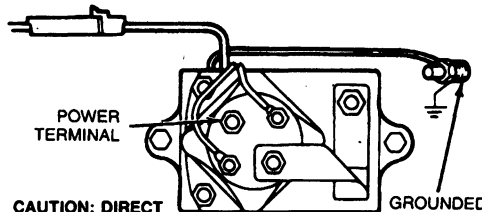
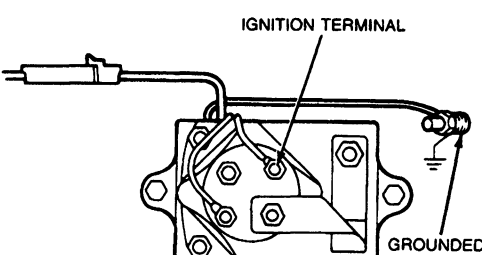
K

TEST STEP		RESULT	ACTION TO TAKE
K2	CHECK HARNESS		
	<ul style="list-style-type: none"> Ignition switch in OFF position and leads removed from glow plugs. Squeeze sides of protective cover and remove.  <p>SQUEEZE SIDES AND LIFT</p> <p>REAR OF ENGINE →</p> <p>A19072-A</p> <ul style="list-style-type: none"> Check continuity between each glow plug lead and test terminal of control unit.  <p>TEST TERMINAL</p> <p>A9972-B</p> <ul style="list-style-type: none"> Is there continuity at all leads? 	<p>Yes</p> <p>No</p>	<p>▶ GO to K3.</p> <p>▶ SERVICE or REPLACE harness. GO to K3.</p>

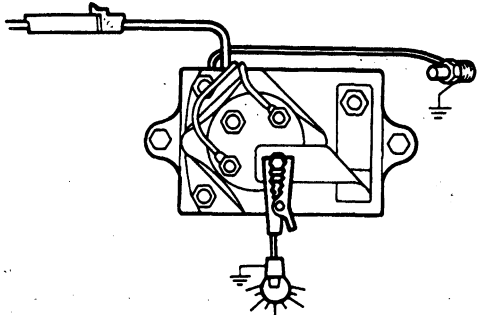
Glow Plug Testing

Pinpoint Test

K

TEST STEP		RESULT	ACTION TO TAKE
K3	CHECK CONTROL UNIT <ul style="list-style-type: none"> Ignition switch in OFF position. Contact ohmmeter to ground wire terminal eyelet and to ground post on each battery.  <p style="text-align: right;">A9973-B</p> <ul style="list-style-type: none"> Is resistance less than 1 ohm? 	Yes No	GO to K4 . CLEAN or SERVICE ground connection. REPEAT check. GO to K4 .
K4	CHECK SUPPLY VOLTAGE <ul style="list-style-type: none"> Ignition switch in OFF position. Connect voltmeter to control unit power terminal and ground.  <p style="text-align: right;">A9974-B</p> <ul style="list-style-type: none"> Is there 10 or more volts? 	Yes No	GO to K5 . SERVICE wiring or RECHARGE battery. GO to K5 .
K5	CHECK VOLTAGE FROM IGNITION SWITCH <ul style="list-style-type: none"> Check voltmeter to Ignition Terminal on control unit and ground. Turn ignition switch to ON position and all accessories off.  <p style="text-align: right;">A9975-B</p> <ul style="list-style-type: none"> Is there 8 or more volts? 	Yes No	GO to K6 . CHECK fusible link, SERVICE wiring or RECHARGE battery. GO to K6 .

Glow Plug Testing**Pinpoint
Test****K**

TEST STEP		RESULT	ACTION TO TAKE																					
K6	FUNCTIONAL TEST																							
<ul style="list-style-type: none">With ignition switch in OFF position connect 12 volt test light to test terminal on control unit.Position test light so it can be viewed from driver's position.Turn ignition switch to ON position and monitor system operation.Compare test light times to Test Light Chart.		Yes	System function is correct.																					
		No	DISCONNECT power at both batteries. REPLACE control unit. REPEAT test.																					
<div></div> <p style="text-align: center;">A9976-B</p> <p>NOTE: Total Test Light "ON" Time includes time from the beginning of the initial "ON" cycle to the end of the last "ON/OFF" cycle measured in seconds.</p> <p style="text-align: center;">TEST LIGHT CHART</p> <table><tr><th>Control Unit Temp. °F</th><th>"Wait-to-Start" Indicator "ON" Time (Sec.)</th><th>Test Light Total Time (Sec.)</th></tr><tr><td>-20°F</td><td>10-18</td><td>35-70</td></tr><tr><td>0°F</td><td>10-16</td><td>30-60</td></tr><tr><td>35°F</td><td>10-16</td><td>30-50</td></tr><tr><td>70°F</td><td>7-13</td><td>15-25</td></tr><tr><td>105°F</td><td>2-8</td><td>5-15</td></tr><tr><td>140°F</td><td>2 or Less</td><td>1-5</td></tr></table> <p>• Temperature of Control Unit, NOT ambient temperature.</p> <p>NOTE: The "Wait-to-Start" Indicator and/or Test Light may not illuminate if engine temperature is at or near normal operating temperature.</p> <ul style="list-style-type: none">Does test light time within specifications?				Control Unit Temp. °F	"Wait-to-Start" Indicator "ON" Time (Sec.)	Test Light Total Time (Sec.)	-20°F	10-18	35-70	0°F	10-16	30-60	35°F	10-16	30-50	70°F	7-13	15-25	105°F	2-8	5-15	140°F	2 or Less	1-5
Control Unit Temp. °F	"Wait-to-Start" Indicator "ON" Time (Sec.)	Test Light Total Time (Sec.)																						
-20°F	10-18	35-70																						
0°F	10-16	30-60																						
35°F	10-16	30-50																						
70°F	7-13	15-25																						
105°F	2-8	5-15																						
140°F	2 or Less	1-5																						

Glow Plug Failure Analysis

The following are examples of Glow Plug Failure. Each example gives a different clue to glow plug failure analysis.

- There is no visible damage, but glow plug is electrically open (Figure 21). This indicates an internal heating element failure.
- Glow plug tip that is missing can be caused by incorrect timing or poor fuel quality (Figure 22).
- Multiple, distorted glow plugs are usually caused by electrical overheating (Figure 23). A complete evaluation of the glow plug control system should be made.

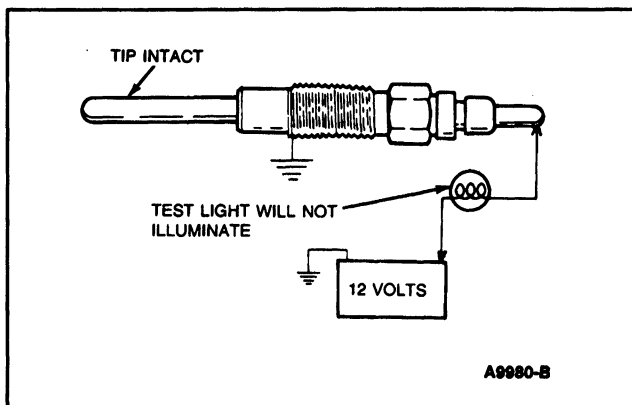


Figure 21: Electrically Open

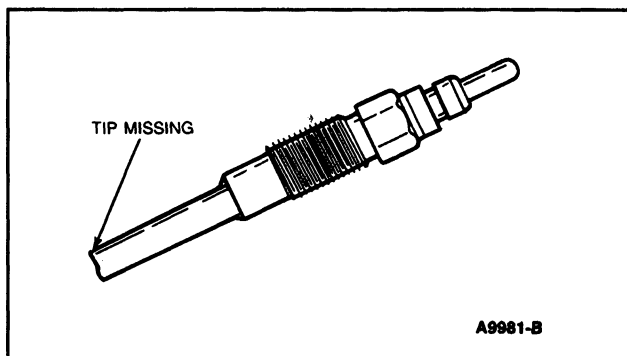


Figure 22: Missing Tips

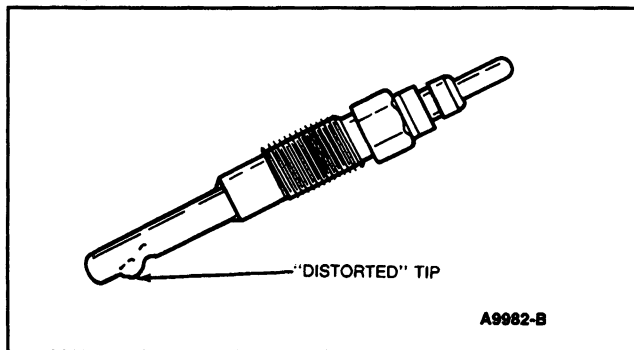


Figure 23: Distorted Tips

Fuel System Air Leak Diagnosis

Hard starting, white smoke in the normal engine operating range, poor idle quality, or lack of power under load can be caused by several conditions. One of these conditions is air leaks in the fuel supply system. This procedure is provided to assist in the diagnosis of 7.3L IDI turbo diesel engine fuel system air leaks.

To perform the Fuel System Air Leak Diagnosis, the following adapters (Figures 24 and 25) need to be assembled as shown from locally available materials.

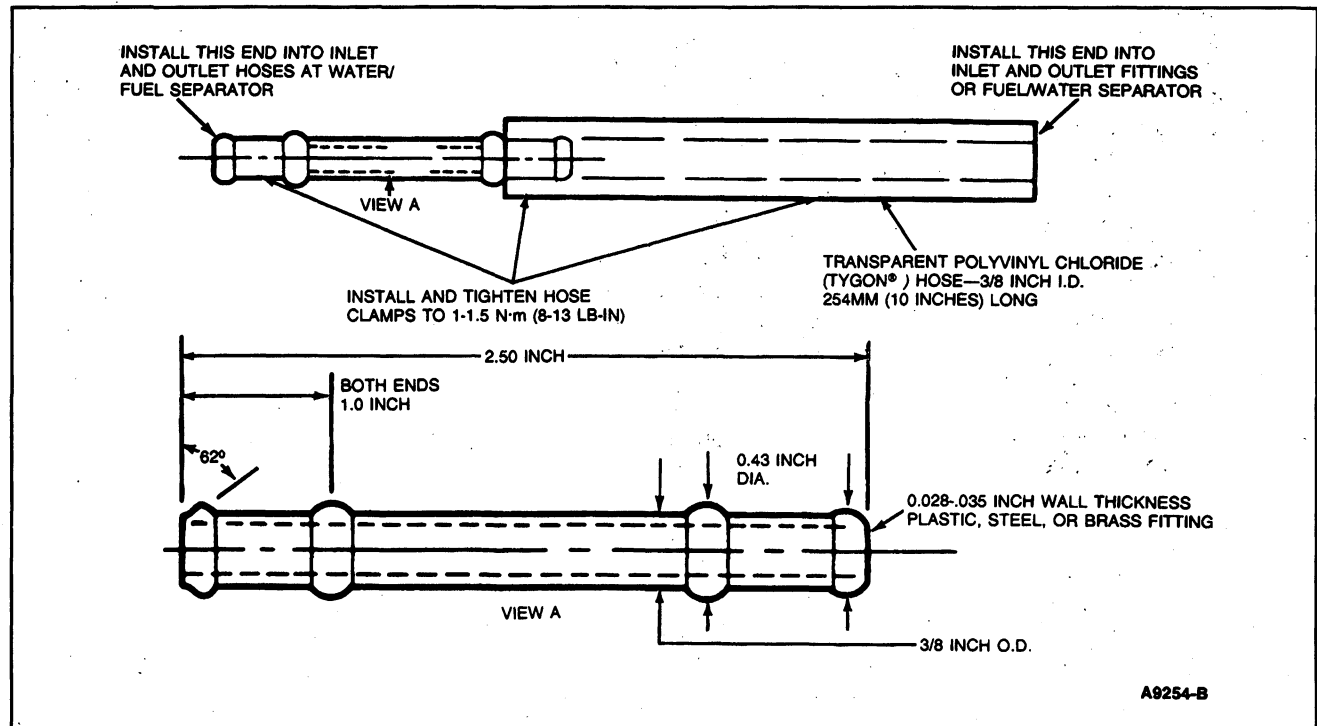


Figure 24: Water/Fuel Separator Adapter, Two Required

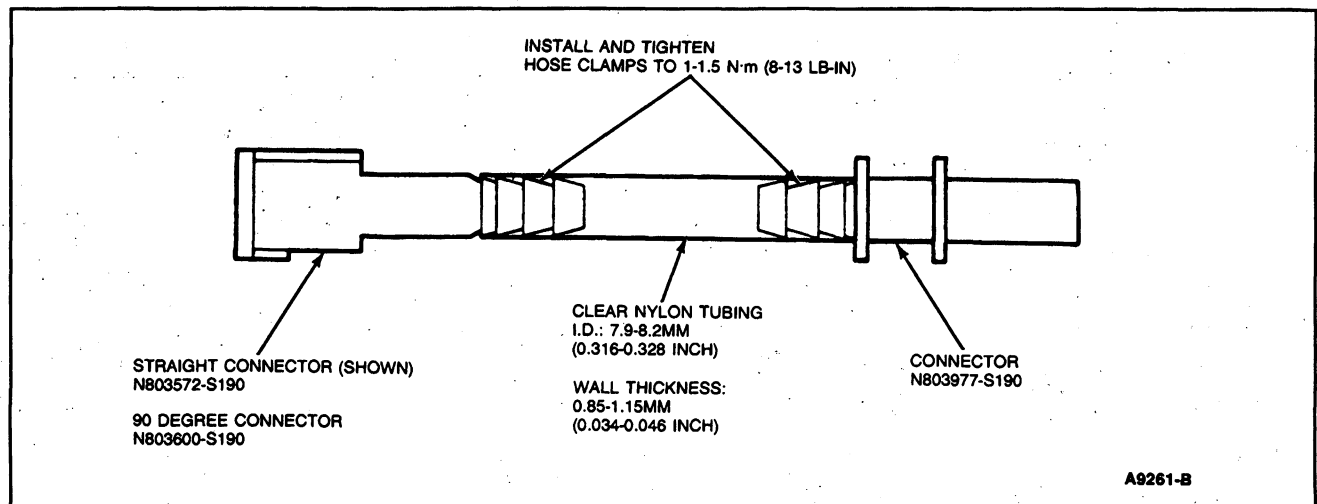
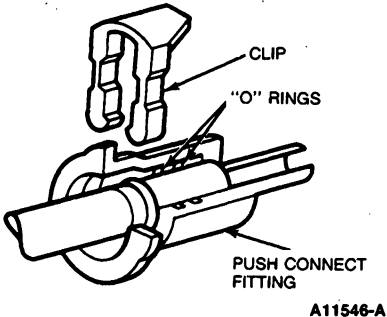


Figure 25: Selector Valve/Fuel Tank Push Connect Adapter—F-Series (Two Required)

Fuel System Air Leak Diagnosis

Pinpoint Test

L

TEST STEP		RESULT	ACTION TO TAKE
L1	CHECK HOSE CONNECTIONS	Yes	▶ GO to L2 .
	<p>NOTE: Prior to starting the diagnostic procedure, verify that the fuel tank(s) contain at least a half tank of fuel—the fuel level compensates for the range of vehicle attitudes that may uncover the fuel sender pickup hose or sender by-pass in the fuel tank when the fuel level is low. Visually inspect the fuel system for obvious problems such as kinked hoses, damaged lines or push-connect fittings.</p> <ul style="list-style-type: none"> • Verify that the push-connect fitting clip is in place. • Verify that the push-connect fittings are properly installed on the tube end by pulling the fitting away from the tube (axially along the tube). The fitting should not pull off from the tube end. If the fitting does pull away, push the fitting axially back on to the tube until a definite click is heard. • Pull and push the fitting one more time to verify proper installation.  <p>Are hose connections OK?</p>	No	▶ SERVICE or REPLACE fuel lines, clamps or push-connect fittings. REFER to Light Truck Service Manual, Section 10-01B, for push-connect fitting service.

Fuel System Air Leak Diagnosis

Pinpoint Test

L

TEST STEP		RESULT	ACTION TO TAKE
L2	CHECK SYSTEM FOR BUBBLES OR FOAM		
	<ul style="list-style-type: none"> Remove the rubber fuel return bypass hose which connects the fuel filter outlet fitting bypass orifice to the return lines at the fuel injection nozzles. <p>CAUTION: Care should be taken when removing or installing hose to the plastic fitting at the fuel injection nozzle return lines. Lubricate hose with diesel fuel to ease installation.</p> <ul style="list-style-type: none"> Install a 305mm (12 inch) length of 3/16 inch I.D. clear polyvinyl chloride, TYGON® hose (to view fuel flow) in place of the above rubber fuel hose, then tighten hose clamps to 1-1.5 N·m (8-13 lb-in). Run engine at approximately 3,000 rpm for two to three minutes to clear air from the system, which was induced by the previous operation. Observe fuel hose for air bubbles at 3,000 rpm. Any continuous stream of bubbles larger than 1.58mm (1/16 inch) indicates air ingestion. A moving concentration of bubbles of any size or foam is unacceptable. <p>NOTE: TYGON® is a registered trademark of Norton Industries Plastics.</p> <ul style="list-style-type: none"> Is a concentration of air bubbles found? 	Yes No	► GO to L3 . ► Concern elsewhere in system. REMOVE TYGON® hose and INSTALL original hose. REFER to Symptom Analysis as outlined.

Fuel System Air Leak Diagnosis

Pinpoint Test

L

TEST STEP		RESULT	ACTION TO TAKE
L2	CHECK SYSTEM FOR BUBBLES OR FOAM (Continued)		

RIGHT SIDE VIEW

FRONT VIEW

F-SERIES

A19073-A

Fuel System Air Leak Diagnosis

Pinpoint Test

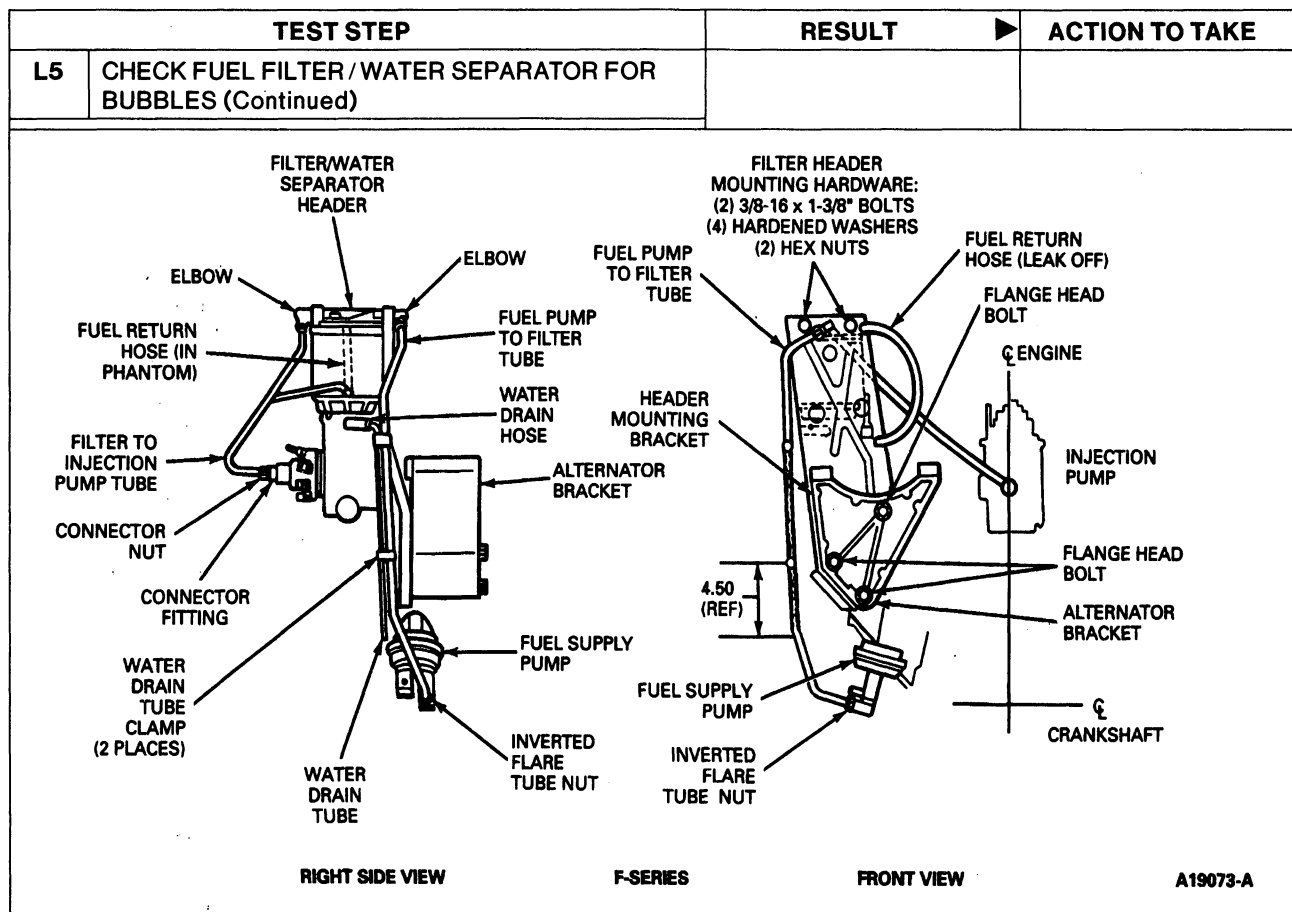
L

TEST STEP		RESULT	ACTION TO TAKE
L3	CHECK DIRECTION OF FLOW		
	<ul style="list-style-type: none"> Observe direction of flow of bubbles. Bubbles should flow from fuel filter outlet fitting to the fuel injection nozzle return system. Is flow of bubbles in the proper direction? 	<p>Yes</p> <p>No</p>	<p>▶ GO to L4 for single tank system.</p> <p>▶ GO to L5 for dual tank system.</p> <p>▶ Fuel System is restricted. GO to Engine Performance Diagnosis in this Section. PERFORM Steps EPC9 through EPC12.</p>
L4	CHECK HOSE CONNECTIONS		
	<ul style="list-style-type: none"> Check for damage to hose connections at rubber fuel hose from chassis fuel line to mechanical lift pump and at inlet and outlet hoses at water separator. Tighten hose clamps to 1-1.5 N·m (8-13 lb-in). After tightening hose clamps, run engine for five minutes at 3,000 rpm and check for air bubbles in TYGON® hose. Are bubbles found? 	<p>Yes</p> <p>No</p>	<p>▶ GO to L5.</p> <p>▶ REPLACE TYGON® hose with original hose. Concern resolved.</p>
L5	CHECK FUEL FILTER / WATER SEPARATOR FOR BUBBLES		
	<p>CAUTION: Disconnect hoses and install adapters one at a time to prevent hose mix-up.</p> <ul style="list-style-type: none"> Disconnect fuel filter / water separator inlet hose. Install hose adapter and tighten clamps to 1-1.5 N·m (8-13 lb-in). Disconnect fuel / water separator outlet hose. Install hose adapter and tighten clamps to 1-1.5 N·m (8-13 lb-in). <p>NOTE: Refer to Air Leak Diagnosis—Hose Adapter procedures as outlined.</p> <ul style="list-style-type: none"> Operate engine at 1,500 rpm for five minutes to develop steady fuel flow. Then, operate engine at 3,000 rpm for an additional two minutes and check for bubbles in hose adapters. 	<p>Air bubbles present in inlet hose, single tank system</p> <p>Air bubbles present in inlet hose, dual tank system</p> <p>Air bubbles present in outlet hose only</p>	<p>▶ SERVICE hoses and connections between fuel / water separator as necessary. REPEAT Test Step L5.</p> <p>▶ GO to L6.</p> <p>▶ CHECK hose adapter at fuel / water separator inlet for air leaks. Operate water / fuel separator drain with engine off. REPEAT Test Step L5.</p> <p>▶ If bubbles persist, REPLACE water / fuel separator. REPEAT Test Step L2.</p>

Fuel System Air Leak Diagnosis

Pinpoint Test

L

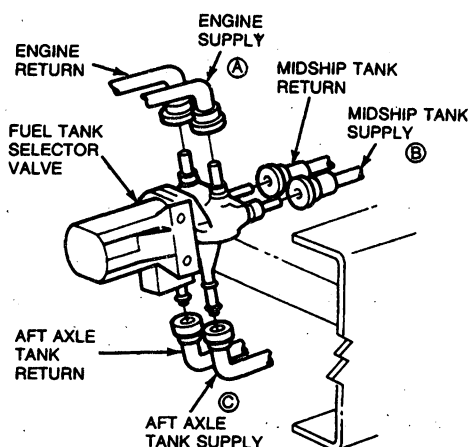


Fuel System Air Leak Diagnosis

Pinpoint Test

L

TEST STEP		RESULT	ACTION TO TAKE
L6	OPERATE SELECTOR VALVE—DUAL TANKS		
	<ul style="list-style-type: none"> Start and run engine. Observe TYGON® hose while switching selector valve between tanks. Are bubbles present in both tank positions? 	Yes No	GO to L4 . GO to L7 .
L7	CHECK SELECTOR VALVE CONNECTIONS		
	<ul style="list-style-type: none"> Check push-connect fittings for tightness as outlined in Test Step L1. Are fittings tight? 	Yes No	GO to L8 . SERVICE push-connect fittings, as necessary. REFER to Service Manual, Section 10-01B for push-connect fitting service.
L8	BY-PASS SELECTOR VALVE		
	<ul style="list-style-type: none"> Disconnect push-connect fittings from fuel tank selector valve for affected tank. Install push-connect fitting adapters between fuel lines and selector valve. Run engine at 3,000 rpm for two to three minutes to clear any air ingested during adapter installation. Run engine an additional one to two minutes and observe transparent fuel lines in adapters. 	Bubbles not present in either adapter Bubbles present in both adapters Bubbles present in selector valve outlet adapter only	Air leak is between fuel tank selector valve and water/fuel separator. SERVICE fuel lines and connections as necessary. REPEAT Test Step L2 . Air leak is between fuel tank and selector valve. SERVICE fuel lines and connections as necessary. REPEAT Test Step L2 . REPLACE fuel tank selector valve. REPEAT Test Step L2 .



1. INSTALL ONE ADAPTER AT POINT A
2. INSTALL OTHER ADAPTER AT: POINT B FOR MIDSHIP TANK
POINT C FOR AFT AXLE TANK

A11549-A

Engine Performance Diagnostic Procedure

The Engine Performance Diagnostic Procedure begins with those items which are the high frequency, easy-to-diagnose problems, and progresses to the low frequency, hard to diagnose problems. Use of this procedure will promote rapid as well as accurate diagnosis.

The Engine Performance Diagnostic Procedure follows, step by step, the Engine Performance Chart. Each test step is labeled to coincide with the Engine Performance Chart steps.

NOTE: Under no circumstances should the fuel injection pump be replaced until the Engine Performance Chart has been completely filled out. The only exceptions to this are in the case of Excessive Black Smoke (Symptom Analysis Diagnostic Procedure H) and external leaks. In these cases, only those steps specified need to be filled out. Warranty claims for the fuel injection pump or injectors will not be accepted unless the Engine Performance Chart is filled out as specified and all tamperproof seals are intact.

NOTE: Service each concern detected before going on to the next step. If service corrects the original complaint, it will not be necessary to proceed to the next test step. However, if the complaint is not corrected, continue with the test until the complaint is corrected.

The following explanations refer to the basic test steps of the Engine Performance Diagnostic Procedure and Chart. They give a brief description of how these problems can affect performance and an understanding of the importance of each test step.

1. **External Leakage:** Fuel leakage may cause diesel fuel smell or low economy. Oil leakage may cause high oil consumption. An air intake system leak can shorten engine life, especially under dusty conditions. Coolant leakage can result in engine overheating.
2. **Accelerator Linkage:** If the accelerator linkage is improperly adjusted, the engine cannot reach full rated rpm and top speed and pulling power will be reduced, or curb idle speed will be excessive.
3. **Exhaust System Condition:** Kinks or dents in the exhaust system can cause high exhaust back pressure. This can result in loss of power and high smoke levels.
4. **Turbocharger Boost:** If the turbocharger is not functioning correctly it may result in low power, excessive smoke and poor fuel economy.
5. **Wastegate Actuator Condition:** If the wastegate actuator is not functioning correctly it could result in an overboost condition (if the wastegate is stuck closed) or poor performance (not reaching desired boost due to wastegate being stuck open).
6. **Fuel System Air Leaks:** Loose connections can leak air into the fuel. This can result in loss of power and high smoke levels.
7. **Fuel Quality:** Diesel engines need clean fuel, free of air, dirt and water. Any contamination may result in poor engine performance.

NOTE: The fuel supply system must deliver the proper quantity of fuel with no pressure loss or air leaks in chassis fuel system.

8. **Fuel System Condition:** Kinks in the fuel lines or hoses can block or restrict fuel flow. This can result in loss of power and high smoke levels.

Engine Performance Diagnostic Procedure

9. **Fuel System Return Line Restriction:** A restriction in the fuel return line will raise the pressure in the injection pump causing an adverse effect on injection pump timing, resulting in excessive smoke levels or loss of power.
10. **Air Cleaner Restriction:** A dirty air cleaner may result in low power, excessive smoke and poor fuel economy.
11. **Engine Idle Speed:** Low engine idle speed may cause stalling or rough running.

NOTE: If the concern is hard starting, follow the procedures for troubleshooting the glow plug system prior to troubleshooting the fuel system.

12. **Injection Timing:** Incorrect timing can be responsible for poor fuel economy, rough idling or hard starting and excessive smoke.
13. **Transfer Pump Pressure:** This is the pressure which is available to charge the injection plunger. Low pressure will result in loss of power, and excessive smoke levels.
14. **Injection Nozzle Test:** The injection nozzles must be removed from the engine for this test. This is a functional test of injection nozzle performance. Incorrect nozzle performance will cause misses, poor fuel economy, loss of power and excessive smoke.
15. **Crankcase Pressure:** This test measures the amount of crankcase blow-by. More blow-by will create high pressures. Crankcase pressure readings, plus rate of oil consumption, should be used to evaluate engine mechanical condition.

To perform the Engine Performance Diagnostic Procedure it will be necessary to connect the Pressure Test Kit, Rotunda 014-00761 or equivalent, to the various components as shown in Figure 26.

Engine Performance Diagnostic Procedure

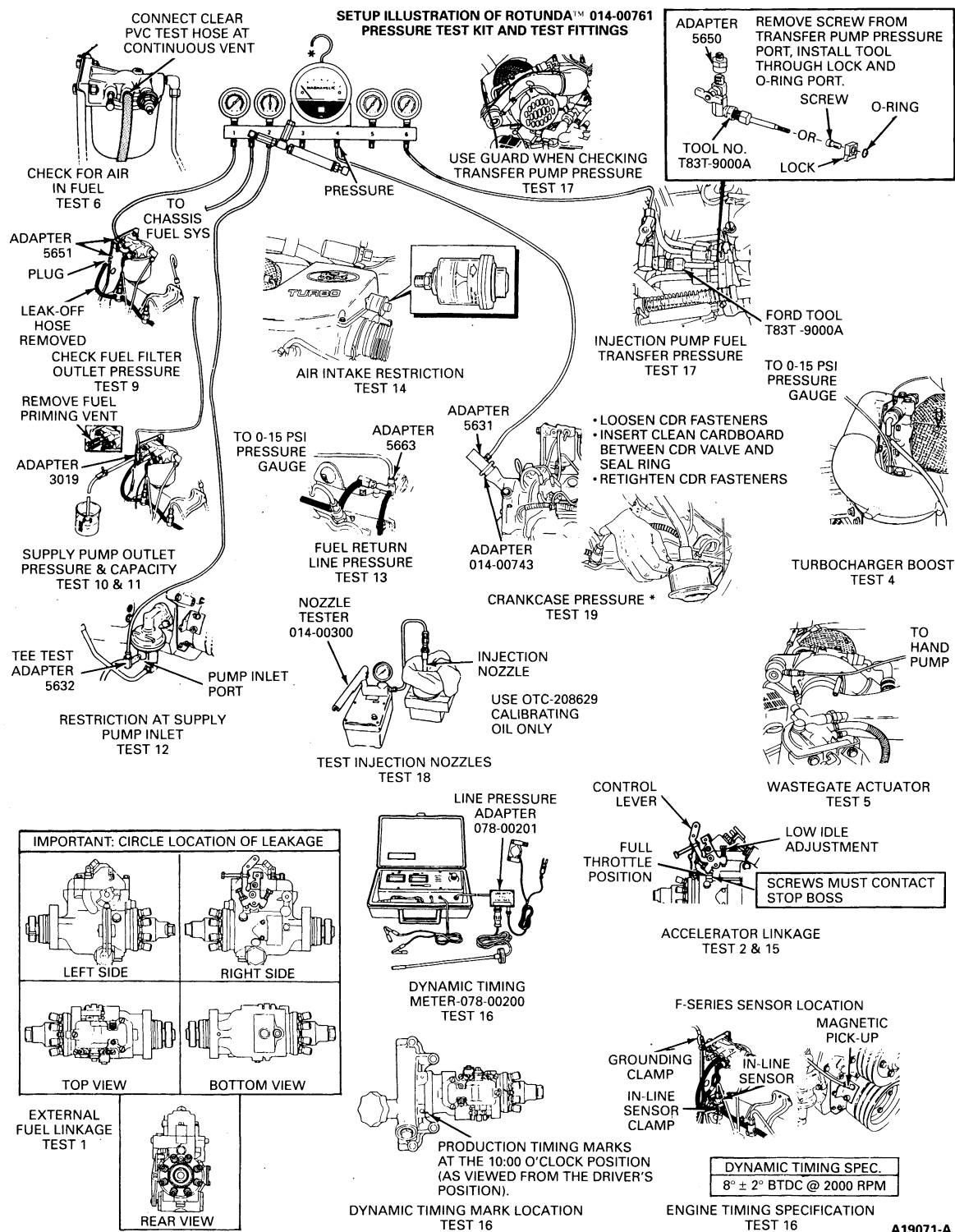
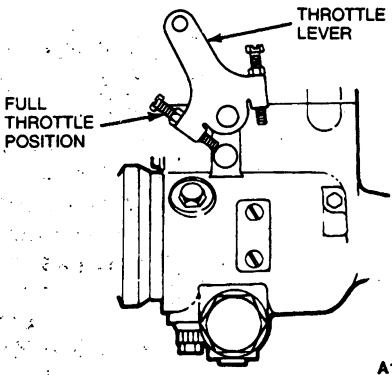


Figure 26: Pressure Test Kit Hookup—Rotunda Model 014-00761

Engine Performance Diagnosis

Pinpoint Test

EPC

TEST STEP		RESULT	ACTION TO TAKE
EPC1	CHECK FOR EXTERNAL LEAKAGE		
<ul style="list-style-type: none"> With engine running, visually check the following for leakage: <ul style="list-style-type: none"> Fuel Engine oil Air intake Coolant Is leakage found? 		Yes	SERVICE or REPLACE damaged component(s). If concern still exists, GO to EPC2 .
		No	GO to EPC2 .
EPC2	ACCELERATOR LINKAGE ADJUSTMENT		
<ul style="list-style-type: none"> With engine off, check that throttle lever contacts injection pump stop at full accelerator pedal depression. Full throttle screw is not adjustable. Tampering may cause injection pump damage. 		Yes	GO to EPC3 .
 <p style="text-align: center;">A11545-A</p> <ul style="list-style-type: none"> Does the throttle lever contact the injection pump stop at full throttle? 		No	ADJUST or SERVICE vehicle throttle linkage as necessary. (Refer to Service Manual, Section 10-02.) GO to EPC3 .
EPC3	CHECK EXHAUST SYSTEM		
<ul style="list-style-type: none"> Visually check exhaust system for dents or kinks which could cause restriction. Is a restriction found? 		Yes	SERVICE or REPLACE exhaust system as required. (Refer to Service Manual, Section 09-00.) GO to EPC4 .
		No	GO to EPC4 .

Engine Performance Diagnosis	Pinpoint Test	EPC
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TEST STEP		RESULT	ACTION TO TAKE
EPC4	CHECK TURBOCHARGER BOOST		
<ul style="list-style-type: none"> Remove air cleaner assembly. Remove test port plug from air chamber. Install Pressure Test Kit 014-00761 or equivalent. Reinstall air cleaner assembly. On vehicles equipped with automatic transmissions, perform a converter stall test (1680-2100 rpm). On vehicles equipped with manual transmissions, perform a load test. While driving the vehicle in second gear accelerate from 1200 rpm to 2800 RPM. Does turbocharger boost read 5 psi (minimum)? 		Yes	Performance is acceptable.
		No	GO to EPC5 .
EPC5	WASTEGATE ACTUATOR CONDITION		
<ul style="list-style-type: none"> Remove air supply line from actuator diaphragm. Install Pressure Test Kit 014-00761 or equivalent. Apply pressure to wastegate actuator with hand pump. <ul style="list-style-type: none"> A. Does rod begin to move at 12-15 psi? B. Does rod obtain full travel at 20-22 psi? C. Observe pressure gauge for 30 seconds after 20-22 psi has been attained. Does actuator hold steady pressure? 		Yes	GO to Step B .
		No	REMOVE rod from wastegate lever and CHECK wastegate for freedom of movement. If wastegate is free, REPLACE actuator. If wastegate will not move, free up or replace wastegate housing; RECHECK rod movement.
		Yes	GO to Step C .
		No	CHECK for bent actuator rod or binding wastegate lever.
		Yes	GO to EPC6 .
		No	REPLACE wastegate actuator.

Engine Performance Diagnosis

Pinpoint Test

EPC

TEST STEP		RESULT	ACTION TO TAKE
EPC6	CHECK FOR AIR IN FUEL		
<p>NOTE: Correct direction of fuel flow is from fuel filter toward fuel return system. Fuel flow in opposite direction is indication of restriction in fuel supply system.</p> <ul style="list-style-type: none"> Install a length of clear PVC hose in place of rubber hose between fuel filter outlet and injection nozzle return system. <p>NOTE: On vehicles with dual fuel tanks, check with tank selector switch in each position for a minimum of two minutes.</p> <ul style="list-style-type: none"> Run engine for two minutes. Then, run engine at 3,000 rpm and check for bubbles in clear hose. 		<p>Fuel flow direction correct, bubbles not present</p> <p>Fuel flow direction correct, bubbles present</p> <p>Fuel flow direction not correct</p>	<p>▶ GO to EPC7.</p> <p>▶ GO to Fuel System Air Leak Diagnosis as outlined. REPEAT Test Step EPC6 when air leaks are eliminated.</p> <p>▶ CHECK for fuel supply restriction. REPEAT EPC6, when fuel flow direction is corrected.</p>
EPC7	CHECK FUEL FOR CONTAMINATION		
<ul style="list-style-type: none"> Obtain a fuel sample and visually examine fuel in a clear container (including bottom of container), for particles, clouding, or liquid contamination, such as water. Is fuel sample free of contamination? 		<p>Yes</p> <p>No</p>	<p>▶ Go to EPC8.</p> <p>▶ REPLACE fuel filter. CLEAN and/or SERVICE fuel system as required. Refer to Service Manual, Section 10-01B. GO to EPC8.</p>
EPC8	CHECK FUEL FOR CETANE VALUE		
<ul style="list-style-type: none"> Check cetane value of fuel sample taken in Test Step EPC7 using cetane tester included with Dynamic Timing Meter, 078-00200 or equivalent. Cetane value should be minimum of 40. Is cetane value 40 or more? 		<p>Yes</p> <p>No</p>	<p>▶ GO to EPC9.</p> <p>▶ Complete Tests EPC7, 8, 9, 10, 11, 14 and 17.</p> <p>▶ INFORM owner to change fuel source. GO to EPC9.</p> <p>NOTE: Do not replace fuel injection pump because of low cetane concern.</p>

Engine Performance Diagnosis

Pinpoint Test

EPC

TEST STEP		RESULT	ACTION TO TAKE
EPC9	FUEL FILTER OUTLET PRESSURE		
<ul style="list-style-type: none"> Remove air bleed orifice hose from fuel filter fitting. Install adapter 5651 with Pressure Test Kit 014-00761 or equivalent. (Refer to Pressure Test Kit Hookup Illustration.) Run engine at 3,000 rpm, with accessories turned off. Record pressure reading. On dual tank vehicles, check both tanks. Pressure should be minimum of 1 psi at 3,000 rpm. Is fuel filter outlet pressure within specifications? 		Yes	▶ GO to EPC11 .
		No	▶ GO to EPC10 .
EPC10	FUEL SUPPLY PUMP OUTLET PRESSURE		
<ul style="list-style-type: none"> Remove vacuum purge valve from fuel filter adapter. Install adapter 3019 and Pressure Test Kit 014-00761 or equivalent. (Refer to Pressure Test Kit Hookup Illustration.) <p>NOTE: Make sure clamp is closed on sampling hose.</p> <ul style="list-style-type: none"> Leave adapter from Test Step EPC6 installed and cap end. Run engine at idle, accessories off. Record pressure reading. On dual tank vehicles, check both tanks. Pressure should be minimum of 2 psi at idle. Is fuel supply pump outlet pressure within specifications? 		Yes	▶ REPLACE fuel filter and REPEAT Test Step EPC9 .
		No	▶ GO to EPC11 .
EPC11	FUEL PUMP CAPACITY		
<ul style="list-style-type: none"> Position end of sample hose on adapter 3019 in a clear, one quart, graduated fuel container. Follow procedures for Test Step EPC10 and open clamp on sample hose, allowing fuel to flow into fuel container, for 30 seconds. Record volume. On dual tank vehicles, check both tanks. Volume should be a minimum of one pint in 30 seconds at idle, accessories off. 		Pressure and volume OK	▶ GO to EPC13 .
		Pressure OK Volume Not OK	▶ GO to EPC12 .
		Volume OK Pressure Not OK	▶ REPLACE fuel supply pump and REPEAT Test Step EPC9 .
		Pressure and Volume Not OK	▶ GO to EPC12 .

Engine Performance Diagnosis	Pinpoint Test	EPC
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TEST STEP		RESULT	ACTION TO TAKE
EPC12	CHECK RESTRICTION AT FUEL SUPPLY PUMP INLET		
	<ul style="list-style-type: none"> ● Connect fuel return line removed in Test Step EPC9. ● Install adapter 5632 and Pressure Test Kit to fuel supply pump inlet. ● With rear wheels off the ground and transmission in NEUTRAL or PARK, run engine at 3,000 rpm. ● Record vacuum reading. On dual tank vehicles, check both tanks. ● Vacuum should be less than 6 in-Hg. ● Is vacuum reading within specifications? 	<p>Yes</p> <p>No</p>	<p>▶ REPLACE fuel supply pump and REPEAT EPC9.</p> <p>▶ SERVICE or REPLACE restricted chassis fuel line(s). Refer to Service Manual, Section 10-01B. REPEAT Test Step EPC9.</p>
EPC13	CHECK FUEL RETURN PRESSURE		
	<ul style="list-style-type: none"> ● Remove fuel return line at junction fitting at left rear of engine. ● Install adapter 5663 and Pressure Test Kit 014-00761, or equivalent. <p>NOTE: Fuel return hose removed in EPC9 must be connected for this test.</p> <ul style="list-style-type: none"> ● Run engine at 3,000 rpm, accessories off, transmission in NEUTRAL or PARK. ● Record pressure reading. On dual tank vehicles, check both tanks. ● Maximum pressure should not exceed 2 psi at 3,000 rpm. ● Is fuel return pressure within specifications? 	<p>Yes</p> <p>No</p>	<p>▶ GO to EPC14.</p> <p>▶ SERVICE or REPLACE fuel return line(s) as necessary. REFER to Service Manual, Section 10-01B. REPEAT Test Step EPC13.</p>
EPC14	CHECK AIR INTAKE RESTRICTION		
	<ul style="list-style-type: none"> ● Check air cleaner restriction indicator located on air cleaner housing. 	<p>Indicator shows no restriction</p> <p>Indicator shows restriction</p>	<p>▶ GO to EPC15.</p> <p>▶ REPLACE filter element and CHECK intake system for blockage. REPEAT Test Step EPC14.</p>
EPC15	CHECK ENGINE IDLE SPEED		
	<ul style="list-style-type: none"> ● Check engine idle speed as outlined under Adjustments. ● Bring engine up to normal operating temperature. ● Idle speed is measured with manual transmission in NEUTRAL and automatic transmission in DRIVE. ● Idle speed is shown on Vehicle Emission Control Information (VECI) decal. ● Is idle speed within specifications? 	<p>Yes</p> <p>No</p>	<p>▶ GO to EPC16.</p> <p>▶ ADJUST as necessary. GO to EPC16.</p>

Engine Performance Diagnosis

Pinpoint Test

EPC

TEST STEP		RESULT	ACTION TO TAKE
EPC16	DYNAMIC INJECTION PUMP TIMING**		
<ul style="list-style-type: none"> ● Install Dynamic Timing Meter and check injection pump timing. (Refer to Dynamic Injection Pump Timing.) Measure at 2,000 rpm, no load. ● Record dynamic timing in Box A, Step 11 of the 7.3L Engine Performance Chart. ● Apply +12 volt battery power to the injection pump timing advance solenoid and record dynamic timing in Box B, Step 10 of the 7.3L Engine Performance Chart. <p>**Engine must be at normal operating temperature.</p>		<p>B is more than 1 degree advanced from A, and A is within ± 2 degrees</p> <p>B is more than 1 degree advanced from A, and A is not within ± 2 degrees</p> <p>B is less than 1 degree advanced from A</p>	<p>▶ GO to EPC17.</p> <p>▶ ADJUST timing. (REFER to Service Manual, Section 03-01D and adjustments.) If performance concern still exists after adjusting timing, GO to EPC17.</p> <p>▶ REPLACE fuel injection pump and REPEAT EPC16.</p>
EPC17	CHECK INJECTION PUMP TRANSFER PRESSURE		
<ul style="list-style-type: none"> ● Remove the air cleaner assembly. <p>WARNING: KEEP HANDS AWAY FROM TURBOCHARGER AIR INLET WHEN ENGINE IS RUNNING OR BODILY INJURY MAY OCCUR. A TURBO CHARGER INLET GUARD IS RECOMMENDED WHEN OPERATING ENGINE WITH AIR INLET OPEN. THE INLET GUARD IS AVAILABLE FROM OTC OR AN EQUIVALENT MAY BE USED.</p> <ul style="list-style-type: none"> ● Remove screw from transfer pump pressure port cover. ● Install Fuel Transfer Pump Pressure Adapter T83T-9000-A through cover and O-ring and into port. Install adapter 5650 and Pressure Test Kit 014-00761 or equivalent. ● Fittings must be tight and not leaking. ● Run engine at 3,000 rpm, no load, with transmission in NEUTRAL. ● Record pressure reading. ● Pressure should be 90 to 120 psi. ● Is injection pump transfer pressure within specifications? 		<p>Yes</p> <p>No</p>	<p>▶ GO to EPC18.</p> <p>▶ REPLACE injection pump. (REFER to Service Manual, Section 03-01D.) If performance concern still exists after installing new pump, CHECK and ADJUST injection pump dynamic timing. (REFER to adjustments in this Section.) If performance concern still exists after adjusting timing, GO to EPC18.</p>

Engine Performance Diagnosis

Pinpoint Test

EPC

TEST STEP		RESULT	ACTION TO TAKE
EPC18	CHECK INJECTION NOZZLES AND INLET LINES		
<p>NOTE: Perform this check only if engine is missing or running roughly.</p> <ul style="list-style-type: none"> Check injection nozzle inlet lines for kinks or restriction. (Refer to Service Manual, Section 03-01D.) Test injection nozzles as outlined in this Section. <p>NOTE: Warranty claims for injection nozzles will not be accepted unless the completed Engine Performance chart is submitted with the returned parts.</p> <ul style="list-style-type: none"> Are lines and nozzle(s) OK? 		<p>Yes</p> <p>No</p>	<p>▶ GO To EPC19.</p> <p>▶ REPLACE damaged injection nozzle fuel inlet lines. (REFER to Service Manual, Section 03-01D.)</p> <p>▶ REPLACE injection nozzles as outlined in this Section and Service Manual, Section 03-01D. If performance concern still exists, GO to EPC19.</p>
EPC19	CRANKCASE PRESSURE TEST		
<ul style="list-style-type: none"> Loosen two crankcase depression regulator bolts. Insert a small piece of cardboard between hose and C.D.R. valve, tighten bolts. Remove oil filler cap and install adapter 5631, and Pressure Test Kit 014-00761, or equivalent. (Refer to Pressure Test Kit Hook-Up illustration.) Make sure dipstick is seated in dipstick tube. Run engine at 3,000 rpm accessories off, with transmission in NEUTRAL. Record pressure reading. Pressure should not exceed 6 inches H₂O at 3,000 rpm. <p>NOTE: Warranty claims for injection pumps will not be accepted unless all tamper-resistant seals are intact and the completed Engine Performance Chart is submitted with the returned parts.</p> <ul style="list-style-type: none"> Is crankcase pressure within specifications? 		<p>Yes</p> <p>No</p>	<p>▶ If the performance concern still exists after completion of the Engine Performance Chart, REPLACE injection pump, and CHECK and ADJUST timing. (REFER to Service Manual, Section 03-01D and Adjustments as outlined.)</p> <p>▶ Concern is internal to the engine. (REFER to Service Manual, Section 03-01D.)</p>

Injection Nozzle Testing

Where ideal conditions of good combustion, specified engine temperature control and absolutely clean fuel prevail, nozzles require little attention. Nozzle trouble is usually indicated by one or more of the following symptoms:

- Smoky exhaust (black)
- Loss of power
- Misfiring
- Increased fuel consumption
- Combustion knock
- Engine overheating

When faulty nozzle operation is suspected on an engine that is misfiring or puffing black smoke, a simple test can be made to determine which cylinder(s) is causing the problem.

- Run the engine at the rpm which makes the problem most pronounced.

WARNING

BE EXTREMELY CAREFUL TO PREVENT BEING STRUCK BY DIESEL FUEL UNDER PRESSURE. DIESEL FUEL AT INJECTION PRESSURE CAN EASILY PIERCE THE SKIN, POSSIBLY CAUSING SEVERE INJURY FROM BLOOD POISONING. IF STRUCK BY PRESSURIZED DIESEL FUEL, SEEK MEDICAL HELP IMMEDIATELY.

- Momentarily loosen the high-pressure fuel inlet line connection on one nozzle assembly one-half to one turn. Then, tighten connection to specification.
- Check each cylinder in the same manner.
- If one nozzle is found where loosening makes no difference in the misfiring, or the puffing black smoke stops, that nozzle should be tested. Test only the suspect nozzle(s).

NOTE: It is advisable to test the nozzles before cleaning them.

Remove suspect nozzles as outlined in Service Manual, Section 03-01D. After removing nozzle(s) from the engine, the Injection Nozzle Test should be performed. This test will provide valuable information regarding the condition of the nozzle(s). A clean workbench, clean washing fluid containers, clean tools and clean hands are all essential to produce satisfactory results.

Figure 27 shows the Rotunda Injection Nozzle Tester, 014-00300 or equivalent used for this test.

Injection Nozzle Testing

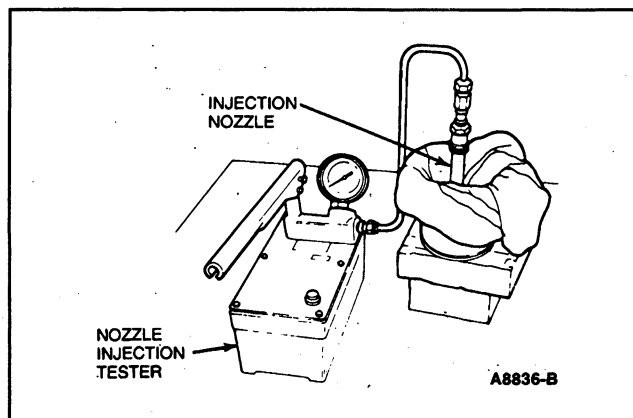


Figure 27: Injection Nozzle Tester 014-00300

NOTE: Perform this check only if engine has an obvious combustion knock or miss.

WARNING

ALWAYS WEAR APPROVED SAFETY GLASSES WHEN OPERATING THE TESTER. VOLATILE LIQUIDS CAN BE EXTREMELY FLAMMABLE WHEN VAPORIZED. AVOID ANY CONDITIONS (SPARKS, OPEN FLAMES, LIT CIGARETTES, ETC.) WHICH MIGHT IGNITE THE FLUID USED DURING THE TEST PROCEDURE. THE ONLY LIQUID APPROVED FOR USE IN THIS TESTER IS SAE CALIBRATION NO. 208629, OR EQUIVALENT CALIBRATION FLUID (SAE J968D OR ISO 4113).

WHEN A NOZZLE IS BEING TESTED OR IS IN OPERATION, KEEP HANDS AND OTHER PARTS OF THE BODY AWAY FROM THE NOZZLE. THE LIQUID DISCHARGE LEAVES THE NOZZLE TIP WITH SUFFICIENT FORCE TO PENETRATE THE SKIN AND CAUSE SERIOUS INJURY. THE NOZZLE TIP SHOULD BE ENCLOSED IN A TRANSPARENT RECEPTACLE IF AVAILABLE.

1. Prepare stand for making tests. Fill stand reservoir with clean Calibration Fluid. Open tester valve slightly and operate tester handle to expel air from tester and outlet pipe. Operate tester until solid fluid (without air bubbles) flows from end of outlet pipe. Close tester valve.
2. Connect injection nozzle to test stand. Care should be taken to avoid cross-threading. Tighten connector nut securely with end wrench. Nozzle Adapter which is supplied with tester 014-00300 has RH thread to nozzle assembly and LH thread to tester piping.
3. Bleed air from nozzle. Open stand valve and operate tester handle for 8 to 10 quick strokes to expel (bleed) air from injection nozzle. Fluid should discharge from the spray hole in nozzle tip.

NOTE: Disregard tip leakage during this test.

NOTE: Spray pattern testing is not required.

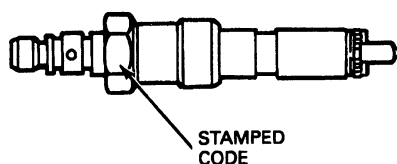
4. Check nozzle opening pressure. Close pump valve, and operate pump handle in slow even strokes to bring system up to pressure. Record highest pressure reached before nozzle opens. Repeat operation, increasing handle speed if necessary to establish consistent readings. Refer to Figure 28 for nozzle opening pressures.

Injection Nozzle Testing

NEW		USED (MINIMUM)	
kPa	PSI	kPa	PSI
13,100 ± 517	1,900 ± 75	9,998	1,450

① CALIBRATION CODE: 468J-R00 AND 468X-R0D.

② BE SURE TO USE INJECTORS WITH STAMPED CODE "G".



A19074-A

Figure 28: Nozzle Opening Pressure

NOTE: Make sure that any accumulation at the nozzle tip is not due to test fluid leaking down the outside of the nozzle body from the return openings. If questionable, wrap a shop cloth around the nozzle body to prevent fluid leaking down the outside of the nozzle body from reaching the tip.

5. Check for tip leakage. Blow nozzle tip dry using filtered compressed air. Operate test pump to maintain pressure at about 1378 kPa (200 psi) below the opening pressure obtained in Test 1. Wetting of the nozzle tip is acceptable as long as a drop does not fall, within five seconds (Figure 29).

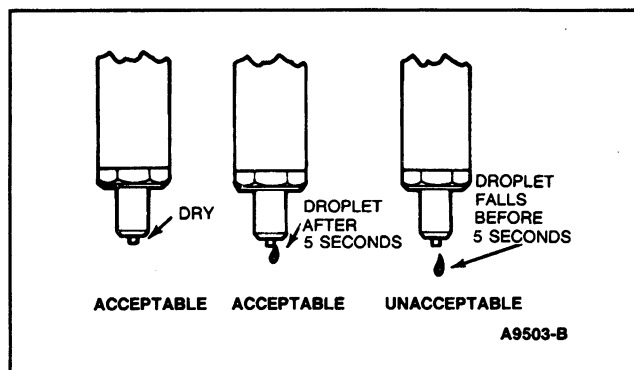


Figure 29: Nozzle Leakage Patterns

Injection Nozzle Testing

6. After testing is completed, make sure to open the pump valve to release the built up pressure prior to removing the nozzle from the tester. When nozzle is removed, cap the nozzle tip and inlet until installed back in engine.

NOTE: If nozzle passes the nozzle opening pressure and tip leakage tests, it is suitable for further service in the engine.

NOTE: Nozzles showing leakage at nozzle tip spray hole or opening pressure below the minimum permissible limit, are damaged or worn and must be replaced, if within warranty coverage. Servicing the nozzle(s) (disassemble, clean and rebuild) instead of replacement to correct nozzle tip leakage or low opening pressure is only permissible beyond the warranty period if so desired.

NOTE: Warranty claims for replacement of the nozzle(s) will not be accepted unless the completed Engine Performance (Diagnostic) Chart is submitted with the returned part(s).

Fuel Injection Pump Lever (FIPL) Sensor

The Fuel Injection Pump Lever (FIPL) sensor is used on F-250, F-350, and F-Super Duty vehicles equipped with a 7.3L IDI turbo diesel engine and an E4OD automatic transmission. The FIPL sensor is bolted to the fuel injection pump and is actuated by the throttle lever.

The FIPL sensor is incorporated to provide an electrical signal, which is proportional to the amount of fuel being delivered, as an input to the Transmission Electronic Control (TEC) Processor. Based on this information, the TEC Processor provides the proper shift scheduling and torque capacity.

Should a malfunction occur in the FIPL sensor circuit, the electrical signal sent to the TEC Processor will be recognized as erroneous. When this out-of-specification signal is detected, the TEC Processor will provide a high capacity operating mode that protects the transmission from potential damage. This operating mode includes: maximum TV pressure, resulting in harsh upshifts and engagements; and a singular shift schedule regardless of accelerator pedal position, resulting in the 1-2, 2-3, and 3-4 shifts occurring at a speed commensurate with a heavy (but not Wide Open) throttle setting.

Should harsh or poorly scheduled shifts be encountered, perform Key-On-Engine-Off Self-Test to determine the appropriate repair to be performed and correct as necessary before proceeding. Should it be necessary to service the FIPL sensor, refer to the "DIAGNOSIS, TESTING, AND ADJUSTMENT — FIPL SENSOR" section.

Diagnosis, Testing, and Adjustment—FIPL Sensor

Fuel Injection Pump Lever (FIPL) Sensor Operational Check and Adjustment (Vehicles Equipped With a 7.3L IDI Turbo Diesel Engine Only)

To check the FIPL sensor for proper operation and to make any adjustments the engine must not be running (TURNED OFF). Refer to Figures 30, 31 and 32.

NOTE: The throttle must be held to the floor, during Key-On-Engine-Off On-Board Diagnostic until the codes have begun to issue from the STAR Tester.

1. Perform Key-On-Engine-Off On-Board Diagnostic and wait for all the service codes to be issued. If any error codes are present see the proper section in the "Engine/Emission Manual," correct as required, and restart this procedure.
2. After the last service code has been issued, press the Overdrive Cancel Switch (OCS). This will initiate the FIPL adjustment mode and allow the STAR Tester to be used as an "audible guide" in setting the FIPL sensor.

NOTE: The STAR Tester remains in the adjustment mode for only 10 minutes, steps 3-6 must be completed within this time period.

3. Remove the throttle cable from the throttle lever on the right side of the fuel injection pump.
4. Remove the throttle return spring. Install one end of the spring over the throttle lever ball stud and the other end over the throttle cable support bracket.
5. Insert Gauge Block T92T-7B200-AH between the gauge boss and the maximum throttle travel screw (Figure 32). The throttle return spring (on F-Series), as repositioned in the above step, will hold the throttle lever open against the gauge block.
6. The FIPL sensor bracket is permanently attached to the pump with tamper proof screws. Movement of the bracket is not intended as a means for adjustment. If required, adjustment of the FIPL sensor may be accomplished by utilizing the clearance between the sensor to bracket screws and the sensor.

To adjust, loosen the two screws that attach the FIPL sensor to the mounting bracket (Figure 33). Rotate the FIPL sensor until a steady tone is heard from the STAR Tester. If the setting is too low the STAR Tester will issue a slow beep, if the setting is too high the STAR Tester will issue a fast beep. Once a steady tone is heard, tighten the attaching screws to 8-10.5 N-m(75-90 lb-in). If the FIPL sensor cannot be adjusted to obtain a steady tone, replace the FIPL sensor and repeat this procedure from Step 1.

7. Remove the gauge block. Cycle the throttle lever from idle to Wide Open Throttle (WOT) 5 times. Reinsert the gauge block to verify the setting. If the tone is not steady then readjustment is necessary. Repeat this procedure from Step 6.

It is important that the FIPL sensor be set to the correct position (a steady tone). If the sensor setting is too low (a slow beep) the shifts will be firmer and more delayed than normal; if it is too high (a fast beep) the shift will be smoother and earlier than normal.

NOTE: If the 10 minute time limit has been exceeded and the STAR tester tone has shut off, repeat this procedure from Step 1.

Diagnosis, Testing, and Adjustment—FIPL Sensor

8. Remove the gauge block. Reattach the throttle return spring and throttle cable in the proper locations.
9. Start the engine. Check throttle operation and transmission shift scheduling and quality.

Fuel Injection Pump Lever FIPL Position Sensor

Diesel Engine

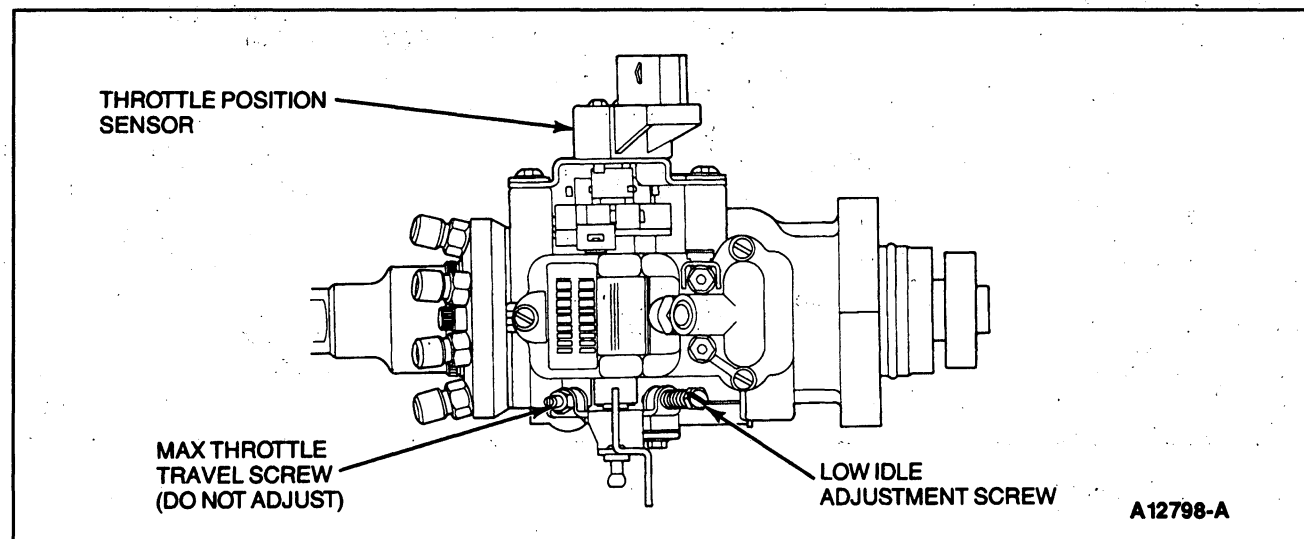


Figure 30: Top View of Fuel Pump

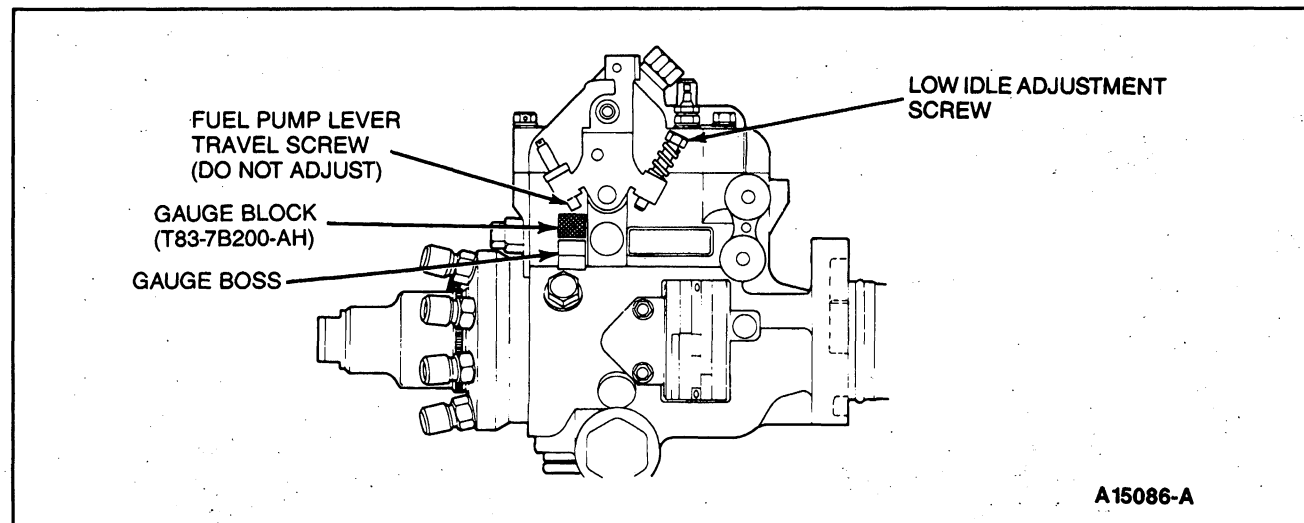
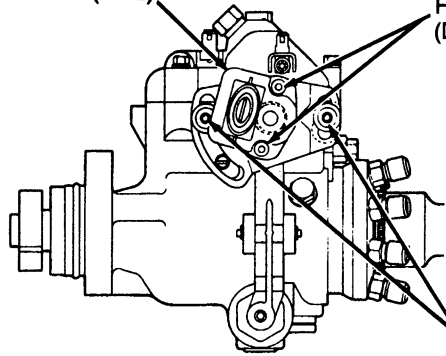


Figure 31: Throttle Side View

Fuel Injection Pump Lever FIPL Position Sensor

FUEL INJECTION PUMP LEVER SENSOR (FIPL)

FIPL SENSOR ATTACHMENT SCREWS
(DO NOT OVERTIGHTEN)



FIPL BRACKET SCREWS
(DO NOT ADJUST)

A12800-B

Figure 32: FIPL Side View

Index/ Important Information

METRICS

**J1930 TERMINOLOGY
LIST**

GLOSSARY

ALPHABETICAL INDEX

**WE WANT TO HEAR
FROM YOU**



INTRODUCTION

Most threaded fasteners are covered by specifications that define required mechanical properties; such as tensile strength, yield strength, proof load and hardness. These specifications are carefully considered in initial selection of fasteners for a given application. To assure continued satisfactory vehicle performance, replacement fasteners used should be of the correct strength, as well as the correct nominal diameter, thread pitch, length, and finish.

Most original equipment fasteners (English system or Metric) are identified with markings or numbers indicating the strength of the fastener. These markings are described in the pages that follow. Attention to these markings is important in assuring that the proper replacement fasteners are used.

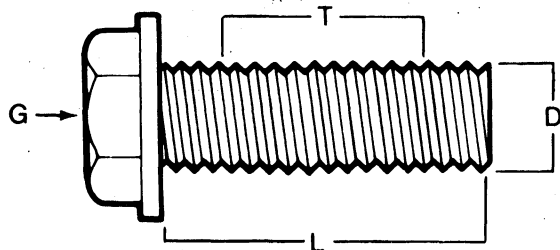
Further, some metric fasteners, especially nuts, are colored blue. This metric blue identification is in most cases a temporary aid for production start-up, and color will generally revert to normal black or bright after start-up.

English system and metric system fasteners are available through your Ford Parts and Service operation.

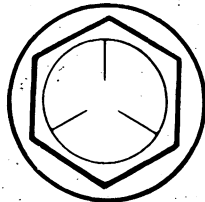
NOMENCLATURE FOR BOLTS

(ENGLISH) INCH SYSTEM

Bolt, 1/2-13x1

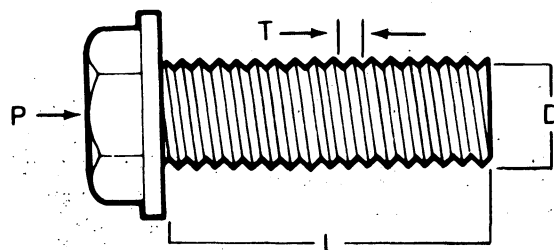


G—Grade Marking
(bolt strength)
L—Length, (inches)**
T—Thread Pitch
(thread/inch)
D—Nominal Diameter
(inches)

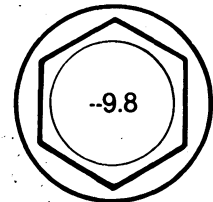


METRIC SYSTEM

Bolt M12-1.75x25



P—Property Class*
(bolt strength)
L—Length (millimeters)**
T—Thread Pitch (thread width
crest to crest mm)
D—Nominal Diameter
(millimeters)



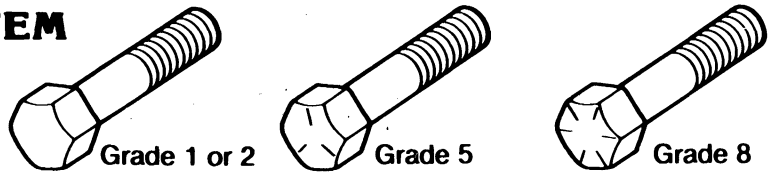
*The property class is an Arabic numeral distinguishable from the slash SAE English grade system.

**The length of all bolts is measured from the underside of the head to the end.

Metrics

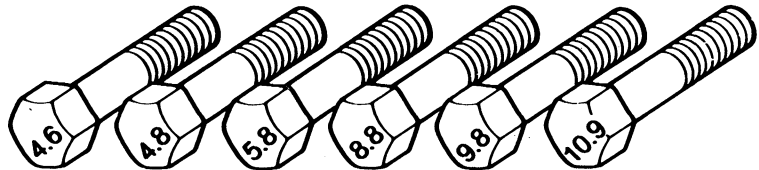
BOLT STRENGTH IDENTIFICATION

(ENGLISH) INCH SYSTEM



English (Inch) bolts—Identification marks correspond to bolt strength—increasing number of slashes represent increasing strength.

METRIC SYSTEM



Metric bolts—Identification class numbers correspond to bolt strength—increasing numbers represent increasing strength. Common metric fastener bolt strength property are 9.8 and 10.9 with the class identification embossed on the bolt head.

HEX NUT STRENGTH IDENTIFICATION

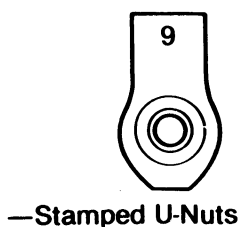
(ENGLISH) INCH SYSTEM

METRIC SYSTEM

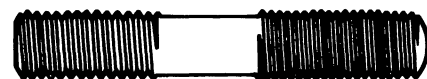
Grade	Hex Nut Grade 5	Hex Nut Grade 8	Class	Hex Nut Property Class 9	Hex Nut Property Class 10
Identification			Identification		
	3 Dots	6 Dots		Arabic 9	Arabic 10
Increasing dots represent increasing strength.			May also have blue finish or paint daub on hex flat. Increasing numbers represent increasing strength.		

OTHER TYPES OF PARTS

Metric identification schemes vary by type of part, most often a variation of that used of bolts and nuts. Note that many types of English and metric fasteners carry no special identification if they are otherwise unique.



—Tapping, thread forming and certain other case hardened screws



CLASS
10.9



CLASS
9.8



CLASS
8.8

—Studs, Large studs may carry the property class number. Smaller studs use a geometric code on the end.

Metrics

ENGLISH METRIC CONVERSION

Description	Multiply	By	For Metric Equivalent
ACCELERATION	Foot/sec ²	0.3048	metre/sec ² (m/s ²)
	Inch/sec ²	0.0254	metre/sec ²
TORQUE	Pound-inch	0.11298	newton-metres (N·m)
	Pound-foot	1.3558	newton-metres
POWER	horsepower	0.746	kilowatts (kw)
PRESSURE or STRESS	inches of water	0.2491	kilopascals (kPa)
	pounds/sq. in.	6.895	kilopascals (kPa)
	pounds/sq. in.	0.069	bar
ENERGY or WORK	BTU	1055	joules (J)
	foot-pound	1.3558	joules (J)
	kilowatt-hour	3,600,000. or 3.6 x 10 ⁶	joules (J = one W's)
LIGHT	foot candle	10.764	lumens/metre ² (lm/m ²)
FUEL PERFORMANCE	miles/gal	0.4251	kilometres/litre (km/l)
	gal/mile	2.3527	litres/kilometre (l/km)
VELOCITY	miles/hour	1.6093	kilometres/hr. (km/h)
LENGTH	inch	25.4	millimetres (mm)
	foot	0.3048	metres (m)
	yard	0.9144	metres (m)
	mile	1.609	kilometres (km)
AREA	inch ²	645.2	millimetres ² (mm ²)
		6.45	centimetres ² (cm ²)
	foot ²	0.0929	metres ² (m ²)
VOLUME	yard ²	0.8361	metres ²
		16,387	mm ³
		16.387	cm ³
	yard ³	0.0164	litres(1)
		0.9464	litres
		3.7854	litres
		0.7646	metres ³ (m ³)
MASS	pound	0.4536	kilograms (kg)
	ton	907.18	kilogram (kg)
	ton	0.90718	tonne (t)
FORCE	kilogram	9.807	newtons (N)
	ounce	0.278	newtons
	pound	4.448	newtons
TEMPERATURE	degree fahrenheit	(°F - 32) 0.556	degree Celsius (°C)

Metrics

DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal Inch	Metric mm
1/64	.015625	.397
1/32	.03125	.794
3/64	.046875	1.191
1/16	.0625	1.588
5/64	.078125	1.984
3/32	.09375	2.381
7/64	.109375	2.778
1/8	.125	3.175
9/64	.140625	3.572
5/32	.15625	3.969
11/64	.171875	4.366
3/16	.1875	4.763
13/64	.203125	5.159
7/32	.21875	5.556
15/64	.234375	5.953
1/4	.250	6.35
17/64	.265625	6.747
9/32	.28125	7.144
19/64	.296875	7.54
5/16	.3125	7.938
21/64	.328125	8.334
11/32	.34375	8.731
23/64	.359375	9.128
3/8	.375	9.525
25/64	.390625	9.922
13/32	.40625	10.319
27/64	.421875	10.716
7/16	.4375	11.113
29/64	.453125	11.509
15/32	.46875	11.906
31/64	.484375	12.303
1/2	.500	12.7

Fractions	Decimal Inch	Metric mm
33/64	.515625	13.097
17/32	.53125	13.494
35/64	.546875	13.891
9/16	.5625	14.288
37/64	.578125	14.684
19/32	.59375	15.081
39/64	.609375	15.478
5/8	.625	15.875
41/64	.640625	16.272
21/32	.65625	16.669
43/64	.671875	17.066
11/16	.6875	17.463
45/64	.703125	17.859
23/32	.71875	18.256
47/64	.734375	18.653
3/4	.750	19.05
49/64	.765625	19.447
25/32	.78125	19.844
51/64	.796875	20.241
13/16	.8125	20.638
53/64	.828125	21.034
27/32	.84375	21.431
55/64	.859375	21.828
7/8	.875	22.225
57/64	.890625	22.622
29/32	.90625	23.019
59/64	.921875	23.416
15/16	.9375	23.813
61/64	.953125	24.209
31/32	.96875	24.606
63/64	.984375	25.003
1	1.00	25.4

Metrics

TORQUE CONVERSION

NEWTON METRES (N·m)	POUND-FEET (LB-FT)
1	0.7376
2	1.5
3	2.2
4	3.0
5	3.7
6	4.4
7	5.2
8	5.9
9	6.6
10	7.4
15	11.1
20	14.8
25	18.4
30	22.1
35	25.8
40	29.5
50	36.9
60	44.3
70	51.6
80	59.0
90	66.4
100	73.8
110	81.1
120	88.5
130	95.9
140	103.3
150	110.6
160	118.0
170	125.4
180	132.8
190	140.1
200	147.5
225	166.0
250	184.4

POUND-FEET (LB-FT)	NEWTON METRES (N·m)
1	1.356
2	2.7
3	4.0
4	5.4
5	6.8
6	8.1
7	9.5
8	10.8
9	12.2
10	13.6
15	20.3
20	27.1
25	33.9
30	40.7
35	47.5
40	54.2
45	61.0
50	67.8
55	74.6
60	81.4
65	88.1
70	94.9
75	101.7
80	108.5
90	122.0
100	135.6
110	149.1
120	162.7
130	176.3
140	189.8
150	203.4
160	216.9
170	230.5
180	244.0

J1930 Terminology List

NOTE: Certain Ford component names have been changed in this Service Manual to conform to Society of Automotive Engineers (SAE) directive J1930.

SAE J1930 standardizes automotive component names for all vehicle manufacturers.

This chart lists new 1993 SAE J1930 component names and the obsolete 1992 component names.

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
4X4 Low	4X4L	- 4X4L - 4X4 Low
Air Conditioning	A/C	- A/C - Air Conditioning
Air Conditioning Clutch	ACC	- ACC - Air Conditioning Clutch
Air Conditioning Cyclic Switch	ACCS	- ACCS - Air Conditioning Cyclic Switch
Air Conditioning Demand	ACD	- ACD - Air Conditioning Demand
Air Conditioning On	ACON	- ACON - Air Conditioning On
Automatic Ride Control	ARC	- ACL - Acceleration Signal
Barometric Pressure	BARO	- BP - Barometric Pressure
Battery Positive Voltage	B+	- BATT+ - Battery Positive
Blower	BLR	- BLR - Blower
Brake On/Off	BOO	- BOO - Brake On/Off
Bypass Air	BPA	- BPA - Bypass Air
Canister Purge	CANP	- CANP - Canister Purge
Charge Air Cooler	CAC	- Intercooler
Clutch Pedal Position switch	CPP switch	- CES - CIS - Clutch Engage Switch - Clutch Interlock Switch
Coast Clutch Solenoid	CCS	- CCS - Coast Clutch Solenoid
Computer Control Dwell	CCD	- CCD - Computer Control Dwell
Constant Control Relay Module	CCRM	- IRCM - Integrated Relay Control Module
Crankshaft Position sensor	CKP sensor	- CPS - VRS - Variable Reluctance Sensor

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Cylinder Identification	CID	– CID – Cylinder Identification
Data Link Connector	DLC	– Self-Test connector
Data Negative	DATA-	– DATA- – Data Negative
Data Output Line	DOL	– DOL – Data Output Line
Data Positive	DATA+	– DATA+ – Data Positive
Daytime Running Lamps	DRL	– DRL – Daytime Running Lamps
Defroster	DEF	– DEF – Defroster
Diagnostic Test Mode	DTM	– Self-Test mode
Diagnostic Trouble Code	DTC	– Self-Test code
Differential Pressure Feedback EGR	DPFE	– DPFE – Differential Pressure Feedback EGR
Distributor Ignition	DI	– CBD – DS – TFI – Closed Bowl Distributor – Duraspark Ignition – Thick Film Ignition
Dual Overhead Cam	DOHC	– DOHC – Dual Overhead Cam
Dual Plug Inhibit	DPI	– DPI – Dual Plug Inhibit
EGR Pressure Transducer	EPT	– EPT – EGR Pressure Transducer
EGR Temperature	EGRT	– EGRT – EGR Temperature
EGR Vacuum Regulator	EVR	– EVR – EGR Vacuum Regulator
EGR Valve Position	EVP	– EVP – EGR Valve Position
Electronic Air Pump	EAP	– EAP – Electronic Air Pump
Electronic Engine Control	EEC	– EEC – Electronic Engine Control
Electronic Ignition	EI	– DIS – EDIS – Distributorless Ignition System – Electronic Distributorless Ignition System
Electronic Pressure Control	EPC	– EPC – Electronic Pressure Control
Electronic Secondary Air Injection	EAIR	– EAM – Electronic Air Management

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Engine Coolant Temperature	ECT	– ECT – Engine Coolant Temperature
Engine RPM sensor	RPM sensor	– RPMS – Engine RPM sensor
Exhaust Gas Recirculation	EGR	– EGR – Exhaust Gas Recirculation
Fan Control	FC	– EDF – Electro-Drive Fan
Flexible Fuel sensor	FF sensor	– FCS – FFS – FFV – Fuel Compensation Sensor – Flex Fuel Sensor
Flexible Fuel vehicle	FF vehicle	– FFV – Flexible Fuel Vehicle
Fuel Pressure Regulator Control	FPRC	– FPRC – Fuel Pressure Regulator Control
Fuel Pump	FP	– FP – Fuel Pump
Fuel Pump Monitor	FPM	– FPM – Fuel Pump Monitor
Governor Control Module	GCM	– GEM – Governor Electronic Module
Ground	GND	– GND – Ground
Headlamp	HDL	– HDL – Headlamp
Heated Oxygen Sensor	HO2S	– HEGO – Heated Exhaust Gas Oxygen Sensor
High Fan Control	HFC	– HEDF – High Speed Electro-Drive Fan
High Fuel Pump	HFP	– HFP – High Fuel Pump
High Output	HO	– HO – High Output
High Swirl Combustion	HSC	– HSC – High Swirl Combustion
Idle Air Control	IAC	– ISC – Idle Speed Control
Idle Air Control Bypass Air	IAC BPA	– ISC-BPA – Idle Speed Control — Bypass Air
Ignition Control Module	ICM	– DIS module – EDIS module – TFI module
Ignition Diagnostic Monitor	IDM	– IDM – Ignition Diagnostic Monitor
Inertia Fuel Shutoff switch	IFS switch	– Inertia Switch

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Intake Air Temperature	IAT	– ACT – Air Charge Temperature
Intake Manifold Runner Control	IMRC	– IAC – Inlet Air Control
Keep Alive Memory	KAM	– KAM – Keep Alive Memory
Keep Alive Power	KAPWR	– KAPWR – Keep Alive Power
Knock Sensor	KS	– KS – Knock Sensor
Low Fan Control	LFC	– EDF – Electro-Drive Fan
Low Fuel Pump	LFP	– LFP – Low Fuel Pump
Malfunction Indicator Lamp	MIL	– CEL – “CHECK ENGINE” Light – “SERVICE ENGINE SOON” Light
Manifold Absolute Pressure	MAP	– MAP – Manifold Absolute Pressure
Manifold Absolute Pressure Per Altitude	MAPPA	– GMAPPA – Governor Manifold Absolute Pressure Per Altitude
Manual Lever Position	MLP	– MLP – Manual Lever Position
Mass Air Flow	MAF	– MAF – Mass Air Flow
Mass Air Flow Return	MAF RTN	– MAF RTN – Mass Air Flow Return
Multiport Fuel Injection	MFI	– EFI – Electronic Fuel Injection
Octane Adjust	OCT ADJ	– OCT ADJ – Octane Adjust
Overhead Cam	OHC	– OHC – Overhead Cam
Oxidation Catalytic Converter	OC	– COC – Conventional Oxidation Catalyst
Park/Neutral Position switch	PNP switch	– NDS – NGS – TSN – Neutral Drive Switch – Neutral Gear Switch – Transmission Select Switch Neutral
Positive Crankcase Ventilation	PCV	– PCV – Positive Crankcase Ventilation
Power Ground	PWR GND	– PWR GND – Power Ground

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Power Steering Pressure switch	PSP switch	<ul style="list-style-type: none"> – PSPS – Power Steering Pressure Switch
Powertrain Control Module	PCM	<ul style="list-style-type: none"> – ECA – ECM – ECU – EEC processor – Engine Control Assembly – Engine Control Module – Engine Control Unit
Pressure Feedback EGR	PFE	<ul style="list-style-type: none"> – EPT – Exhaust Pressure Transducer
Profile Ignition Pickup	PIP	<ul style="list-style-type: none"> – PIP – Profile Ignition Pickup
Programmable Speedometer/Odometer Module	PSOM	<ul style="list-style-type: none"> – PSOM – Programmable Speedometer/Odometer Module
Pulsed Secondary Air Injection	PAIR	<ul style="list-style-type: none"> – MPA – PA – Thermactor II – Managed Pulsé Air – Pulse Air
Reduction Oxidation Catalytic Converter	REDOX	<ul style="list-style-type: none"> – REDOX – Reduction Oxidation Catalytic Converter
Scan Tool	ST	<ul style="list-style-type: none"> – GST – NGS – Generic Scan Tool – New Generation STAR Tester
Secondary Air Injection	AIR	<ul style="list-style-type: none"> – AM – CT – MTA – Air Management – Conventional Thermactor – Managed Thermactor Air – Thermactor
Secondary Air Injection Bypass	AIRB	<ul style="list-style-type: none"> – AM1 – TAB – Air Management 1 – Thermactor Air Bypass
Secondary Air Injection Diverter	AIRD	<ul style="list-style-type: none"> – AM2 – TAD – Air Management 2 – Thermactor Air Diverter
Self-Test Input	STI	<ul style="list-style-type: none"> – STI – Self-Test Input
Self-Test Output	STO	<ul style="list-style-type: none"> – STO – Self-Test Output
Sequential Multiport Fuel Injection	SFI	<ul style="list-style-type: none"> – SEFI – Sequential Electronic Fuel Injection

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Shift Indicator Lamp	SIL	– SIL – Shift Indicator Lamp
Shift Solenoid	SS	– SS – Shift Solenoid
Signal Return	SIG RTN	– SIG RTN – Signal Return
Solid State Relay	SSR	– SSR – Solid State Relay
Spark Output	SPOUT	– SAW – Spark Angle Word
Speed Density	SD	– SD – Speed Density
Super High Output	SHO	– SHO – Super High Output
Supercharger/Supercharged	SC	– SC – Supercharger/Supercharged
Tachometer	TACH	– TACH – Tachometer
Three Way Catalytic Converter	TWC	– TWC – Three Way Catalytic Converter
Three Way + Oxidation Catalytic Converter	TWC+OC	– TWC & COC – Three Way Catalyst and Conventional Oxidation Catalyst
Throttle Body	TB	– TB – Throttle Body
Throttle Body Injection	TBI	– CFI – Central Fuel Injection
Throttle Position	TP	– TP – Throttle Position
Throttle Position Output	TPOUT	– TPOUT – Throttle Position Output
Torque Converter Clutch	TCC	– CCC – CCO – MCCC – Converter Clutch Control – Converter Clutch Override – Modulated Converter Clutch Control
Torque Converter Clutch solenoid	TCC solenoid	– LUS – MLUS – Lock Up Solenoid – Modulated Lock Up Solenoid
Transmission Control Module	TCM	– 4EAT Module
Transmission Control Switch	TCS	– TCS – Transmission Control Switch

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Transmission Control Indicator Lamp	TCIL	- TCIL - Transmission Control Indicator Lamp
Transmission Oil Temperature	TOT	- TOT - Transmission Oil Temperature
Transmission Range Reverse	TRR	- TSR - Transmission Select Switch Reverse
Transmission Range Overdrive	TROD	- TSOD - Transmission Select Switch Overdrive
Transmission Range Drive	TRD	- TSD - Transmission Select Switch Drive
Transmission Range Low	TRL	- TSL - Transmission Select Switch Low
Transmission Speed Sensor	TSS	- TSS - Transmission Speed Sensor
Turbocharger/Turbocharged	TC	- TC - Turbocharger/Turbocharged
Variable Control Relay Module	VCRM	- VRCM - Variable Relay Control Module
Vehicle Power	VPWR	- VPWR - Vehicle Power
Vehicle Speed Sensor	VSS	- VSS - Vehicle Speed Sensor
Wide Open Throttle	WOT	- WOT - Wide Open Throttle

Glossary

The glossary is a list of technical terms or acronyms and their definitions. It is not intended to be a dictionary of components and their functions. If you desire a detailed description of a specific component, refer to the related Service Manual Group.

4EAT: 4-Speed Electronic Automatic Transaxle.

4X4L: 4X4 Low input switch.

A4LD: Automatic 4-Speed Lock-up – converter Drive.

ACC: A/C Clutch Compressor signal input to the EEC-IV processor relating status of the A/C clutch.

ACCS: A/C Cycling Switch.

ACD: Air Conditioner Demand switch.

ACL: Automatic Adjustable Shock Controller.

A/C: Air Conditioning.

A/C DV: Air Cleaner Duct and Valve motor.

A/CL BIMET: Air Cleaner Bimetal sensor.

A/C P: A/C Pressure Cut-out switch.

ACV: (Thermactor) Air Control Valve.

AHFSS: Air Conditioning/Heater Function Select Switch input to the EEC-IV processor relating status of the A/C heater function select switch.

AIR (THERMACTOR): Secondary Air Injector. A system for injection of air into the exhaust system to aid in the control of hydrocarbon and carbon monoxides in the exhaust.

AIRB (AM1): Secondary Air Injector Bypass.

AIRB/AIRD (TAB/TAD): Secondary Air Injection Bypass/Diverter.

AIR BPV: (Thermactor) Air Bypass Valve.

AIRD (AM2): Secondary Air Injector Diverter.

AMBIENT TEMPERATURE: Temperature of air surrounding an object e.g., temperature where vehicle is being worked on.

ANTI-BFV: Anti-Backfire Valve.

AOD: Automatic Overdrive.

A/T: Automatic Transaxle.

ATDC: After Top Dead Center.

AVOM: Analog Volt-Ohm Meter.

AXOD: Automatic Transaxle Overdrive.

AXOD-E: Automatic Transaxle Overdrive, Electronically Controlled.

B+ (BATT+): Battery Positive Voltage.

BARO (BP): Barometric Pressure Sensor.

BASE IDLE: Idle RPM determined by throttle lever hardset on throttle body while Idle Speed Control is fully retracted and disconnected.

BATT: Battery.

BATT (-): Battery negative post or its circuit.

BOB: (Breakout Box) An EEC-IV test device which connects in series with the processor and the EEC-IV harness and permits measurements of processor inputs and outputs.

BOO: Brake On-Off input to the EEC-IV processor indicating a braking drive mode.

BPA: By-Pass Air Solenoid. Used to control idle speed on EFI and SEFI vehicles.

BREAKOUT BOX: A service tool that “tees” in-between the EEC-IV processor and the 60-pin harness connector. The breakout box contains 60 test pins that can be probed for EEC-IV testing.

BTDC: Before Top Dead Center.

BV: Bowl Vent (Carburetor Fuel Bowl).

BVT: Back Pressure Variable Transducer.

CANP: Canister Purge solenoid or its control circuit.

CARB (FBC): Carburetor.

Glossary

CATALYST: A muffler-like device in the exhaust system containing a monolithic substrate (a ceramic honeycomb structure) that is coated with catalytic metals such as platinum or palladium. When hot exhaust gases come in contact with these metals a chemical reaction takes place to consume unburned hydrocarbon, carbon monoxide and nitrous oxides.

CCD: Computer Controlled Dwell.

CCRM (IRCM): Constant Control Relay Module.

CFAN: Condenser Fan Relay.

CCS: Coast Clutch Solenoid or its control circuit.

CFI: Central Fuel Injection. A computer controlled fuel metering system which sprays atomized fuel into a throttle body mounted atop the intake manifold.

“CHECK ENGINE” OR “SERVICE ENGINE SOON” LAMP: A dash panel lamp used either to aid in the identification and diagnosis of EEC system problems or to indicate that maintenance is required on non-EEC equipped vehicles.

CID: Cylinder Identification sensor or its signal circuit.

CKP (VR or VRS): Crankshaft Position Sensor. A non-contact CKP transducer that converts mechanical motion into electrical control signals.

CKP (PIP): Crankshaft Position.

CLC: Converter Lock-up Clutch.

CLUTCH: Clutch engagement switch or its control circuit.

COMPUTED TIMING: The total spark advance in degrees before top dead center. Calculated by the EEC-IV processor based on input from a number of sensors.

CONTINUOUS SELF-TEST: A continuous test of the EEC-IV system conducted whenever the vehicle is in operation.

CPP (CES): Clutch Pedal Position.

CSE GND: Case Ground (EEC-IV processor case).

CURB IDLE: Computer controlled idle rpm.

CWM: Cold Weather Modulator.

DCL: Data Communications Link.

DFI (FI): Direct Fuel Injection.

DFS: Decel Fuel Shut-off.

DI (CBD): Distributor Ignition.

DI (EDIS): Distributor Ignition.

DI (TFI): Distributor Ignition.

DLC: Data Link Connector.

DOL: Data Output Link. Fuel calculation data from the EEC-IV processor to the electronic tripminder.

DPDIS: Dual Plug Distributorless Ignition System.

DPH: Dual Plug Head.

DPI: Dual Plug Inhibit.

DSS: Down Shift Solenoid.

DV: Delay Valve.

DVOM: Digital Volt-Ohm Multimeter that displays voltage or resistance measurements in digital form on a Liquid Crystal Display (LCD).

DV TW: Delay Valve Two-Way.

EATC: Electronic Automatic Temperature Control.

E4OD: Electronic 4-Speed Overdrive transmission.

ECA: Electronic Control Assembly.

ECT: Engine Coolant Temperature sensor or its signal circuit.

ECTF: Cooling Fan Engine Coolant Temperature sensor.

EEC: Electronic Engine Control. A computer controlled system of engine control.

EEGR: Electronic EGR Valve (Sonic).

EGR: Exhaust Gas Recirculation system designed to allow the flow of inert exhaust gases into the combustion chamber to cool the combustion and thus reduce nitrous oxides in the exhaust.

Glossary

EGRC: EGR Control vacuum solenoid valve or its control circuit.

EGR S/O: EGR Shut-Off.

EGRT: EGR Temperature sensor.

EGRV: EGR Vent vacuum solenoid valve or its control circuit.

EHC: Exhaust Heat Control vacuum solenoid valve or its control circuit.

EI (DIS): Electronic Ignition.

ENGINE RUNNING SELF-TEST: A test of the EEC-IV system conducted with the engine running and the vehicle at rest.

EPC: Electronic Pressure Control (used in E4OD transmissions).

ER: Engine Running Self-Test (same as KOER).

ERS: Engine RPM Sensor or its signal circuit.

EVP: EGR Valve Position sensor or its signal circuit.

EVR: EGR Vacuum Regulator solenoid or its control circuit.

FC (EDF): Fan Control.

FCS: Fuel Control Solenoid or its control circuit.

FF (FCS): Flexible Fuel.

FIPL: Fuel Injection Pump Lever sensor or its signal circuit.

FLC: Fluid Lock-Up Converter.

FMEM: Failure Mode Effects Management. This alternative strategy protects vehicle function from adverse effects of an EEC component failure.

FP: Fuel Pump relay or its control circuit.

FPM: Fuel Pump Monitor. A circuit in the EEC system used to monitor the electric fuel pump operation on some EEC-IV equipped vehicles.

FTO: Filtered Tach Output. An output from the DIS TFI-IV module which provides a filtered ignition signal to the processor in order to control dwell.

FUEL RICH/LEAN: A qualitative evaluation of air/fuel ratio based on an A/F value known as stoichiometry or 14.7. In the EEC-IV system rich/lean is determined by a voltage signal from the EGO sensor. An excess of oxygen (lean) is an EGO voltage of less than 0.4 volts, a rich condition is indicated by an EGO voltage of greater than 0.6 volts.

FWD: Front Wheel Drive.

GND or GRND: A common ground circuit for all vehicle power.

GOOSE: A brief opening and closing of the throttle.

HALL EFFECT: A process where current is passed through a small slice of semi-conductor material at the same time as a magnetic field to produce a small voltage in the semi-conductor.

HBV: Heater Blower Voltage input to the EEC-IV processor reflecting heater blower voltage demand.

HFC (HEDF): Fan Control.

HIC: Hot Idle Compensator.

HLOS: Hardware Limited Operation Strategy. Certain types of computer malfunctions will place the EEC-IV processor into HLOS mode. Output commands are replaced with fixed values.

HO: High Output.

HO2S (HEGO): Heated Oxygen Sensor.

HSC: High Swirl Combustion.

IAS: Inlet Air Solenoid valve or its control circuit.

IAT (ACT): Intake Air Temperature.

IAT (VAT): Intake Air Temperature.

IBP: Integral Back Pressure.

IDLE LIMITER: A device to control minimum and maximum idle fuel richness. The idle limiter is intended to prevent unauthorized persons from making overly rich idle adjustments.

Glossary

IDM: Ignition Diagnostics Monitor. A continuous monitor of the ignition input to the EEC-IV processor used to detect intermittent ignition faults.

IGN: Ignition circuit or system.

INJ: Injector (Fuel).

INJ GND: Injector Ground (Fuel).

ISC: Idle Speed Control. Currently there are two types of computer controlled idle speed controls: DC motor ISC and air bypass ISC.

ITR: In-Tank Reservoir.

ITS: Idle Tracking Switch. Used on CFI vehicles to inform EEC if the throttle is in contact with the DC motor.

KAM: Keep Alive Memory. A series of vehicle battery powered memory locations in the microprocessor which allows the microprocessor to store input failures identified during normal operation for use in later diagnostic routines and adapts some calibration parameters to compensate for changes in the vehicle system.

KAPWR: Keep Alive Power.

KEY ON ENGINE RUNNING SELF-TEST: A test of the EEC-IV system conducted with power applied and the engine at idle.

KOEO: Key On Engine Off Self-Test.

KOER: Key On Engine Running Self-Test (same as Engine Running (ER) Self-Test).

KS: Knock Sensor or its signal circuit.

L: Liters.

MA or MAF: Mass Air Flow sensor or its signal circuit.

MAP: Manifold Absolute Pressure sensor or its signal circuit.

MC (FBC): Mixture Control.

MC-VAF: Measuring Core Volume Air Flow Meter.

MECS: Mazda Equipped Control System.

MFI (EFI): Multiport Fuel Injection. A computer controlled fuel system that distributes atomized fuel through an injector located in each intake port of the engine. The fuel injectors are fired using bank-to-bank circuitry.

MIL: Malfunction Indicator Lamp. An electric circuit between the EEC-IV processor and the "CHECK ENGINE" or "SERVICE ENGINE SOON" lamp on the dash panel of EEC-equipped vehicles.

MLP: Manual Lever Position switch or its signal circuit.

MONITOR BOX: An optional EEC-IV test device which connects in series with the EEC-IV processor and its harness, and permits measurements in various units of processor inputs and outputs.

M/T: Manual Transaxle.

O2S (EGO): Oxygen Sensor.

OASIS: On-line Automobile Service Information System.

OBD (SELF-TEST): On-Board Diagnostic.

OCC: Output Circuit Check.

OC (COC): Oxidation Catalytic Converter.

OCIL: Overdrive Cancel Indicator Lamp.

OCS: Overdrive Cancel Switch.

OCT ADJ: Octane Adjust device which modifies spark advance.

OHC: Overhead Cam.

OPEN CIRCUIT: A circuit which does not provide a complete path for the flow of current.

OSC: Output State Check.

OVERLAY CARD: A plastic card used with the Monitor box to identify EEC-IV signals for each engine. The card also programs the monitor for auto mode measurements.

PAIR (THERMACTOR II): Pulsed Secondary Air Injection. See Pulse Air System.

Glossary

PCM (MCU): Powertrain Control Module.

PCV: Positive Crankcase Ventilation. A system which controls the flow of crankcase vapors into the engine intake manifold where they are burned in combustion rather than being discharged into the atmosphere.

PFE: Pressure Feedback EGR sensor or its signal circuit.

PNP (NDS): Park/Neutral Position Switch.

PNP (NGS): Neutral Gear Switch or its signal circuit.

PNP (NPS): Park/Neutral Position Switch.

PROCESSOR: EEC-IV Electronic Control Assembly.

PSG: Pulse Signal Generator.

PSP (PSPS): Power Steering Pressure switch.

PULSE AIR SYSTEM: Part of the emission control system that utilizes a reed-type check valve which allows air to be drawn into the exhaust system as a result of exhaust pulses.

PVS: Ported Vacuum Switch.

PWR GND: Power Ground.

QUICK TEST: A functional diagnostic test of the EEC system consisting of vehicle preparation and hookup. Key On Engine Off, Engine Running and Continuous Self-Tests.

RECORDER: An optional EEC-IV test device which works jointly with the Monitor box. It allows up to 8 EEC-IV signals to be electronically recorded over a 50 second period.

RELAY: A switching device operated by a low current circuit which controls the opening and closing of another circuit of higher current capacity.

RELIEF VALVE: Pressure limiting valve located in the exhaust chamber of the thermactor air pump. It functions to relieve part of the exhaust airflow if the pressure exceeds a calibrated value.

RWD: Rear Wheel Drive.

SC: Super Charged.

SCB (SBS): Supercharger Bypass.

SDV: Spark Delay Valve.

SFI (SEFI): Sequential Multiport Fuel Injection. A computer controlled fuel system that distributes atomized fuel through an injector located in each intake port of the engine. Each injector is fired separately and has individual circuits.

SHO: Super High Output.

SHORT CIRCUIT: An undesirable connection between a circuit and any other point.

SIG RTN: Signal Return circuit for all sensor signals except HEGO.

SIL: Shift Indicator Light. A system that provides a visual indication to the driver of a vehicle when to shift to the next higher gear to obtain optimum fuel economy.

SOLENOID: A wire coil with a moveable core that changes position by means of electro-magnetism when current flows through the coil.

SPOUT: Spark Output Signal from the EEC-IV processor.

SPOUT (SAW): Spark Output.

SS1: Shift Solenoid 1 or its control circuit.

SS2: Shift Solenoid 2 or its control circuit.

SS 3/4-4/3: Shift Solenoid 3/4-4/3. Output from the EEC-IV processor to the transmission that selects 3rd and 4th gears.

STAR: Self-Test Automatic Readout. A testing device in which the EEC and MCU systems output service codes in a digital format.

STI: Self-Test Input circuit in the EEC and MCU systems used to initiate Self-Test.

STO: Self-Test Output circuit in the EEC and MCU systems that transmits diagnostic trouble codes (pulses) to either a VOM or STAR tester.

TBI (EFI): Electronic Fuel Injection. A computer controlled system that distributes atomized fuel through an injector located in each intake port of the engine. The fuel injectors are fired using bank-to-bank circuitry.

Glossary

TCC (CCC): Torque Converter Clutch.

TCC (CCO): Torque Converter Clutch.

TCC (LUS): Torque Converter Clutch.

TCM: Transaxle Control Module.

TCP: Temperature Compensated (Acceleration) Pump.

TGS: Top Gear Switch. A lock out mechanism that prevents the SIL from lighting when the vehicle is in top gear.

THS: Transmission Hydraulic Switch. An input to the processor that indicates the occurrence of a shift between specific gears.

THS 3/2: Transmission Hydraulic Switch 3rd/2nd gear.

THS 4/3: Transmission Hydraulic Switch 4th/3rd gear.

TIMING: Relationship between spark plug firing and piston position usually expressed in crankshaft degrees before (BTDC) or after (ATDC) top dead center of the compression stroke.

TIV: Thermactor Idle Vacuum valve.

TK: Throttle Kicker vacuum solenoid valve or its control circuit.

TOT: Transmission Oil Temperature sensor or its signal circuit.

TP: Throttle Position sensor or its signal circuit.

TSP: Throttle Solenoid Positioner.

TTS: Transmission Temperature Switch.

TVV: Thermal Vent Valve.

TVV (TVS): Thermal Vacuum Valve.

TWC: Three Way Catalyst.

VAF: Vane Air Flow sensor or its signal circuit.

VBAT: Vehicle Battery voltage.

VCK-V: Vacuum Check Valve.

VCV: Vacuum Control Valve.

VDV: Vacuum Delay Valve.

VM: Vane Meter.

VOM: Volt-Ohm Meter used to measure voltage and resistance. Readings are indicated by sweep hand on a printed scale rather than a digital display.

VOTM: Vacuum Operated Throttle Modulator.

VPWR: Vehicle Power supply voltage regulated to 10-14 volts.

VR/S: Vacuum Regulator/Solenoid.

VRDV: Vacuum Retard Delay Valve.

VREF: Reference voltage supplied by the EEC-IV processor to some sensors and regulated to 4-6 volts.

VRESER: Vacuum Reservoir.

VREST: Vacuum Restrictor.

VRIS: Variable Resonance Induction System.

VRV: Vacuum Regulator Valve.

VSC: Vehicle Speed Control sensor or its signal circuit.

VSS: Vehicle Speed Sensor or its signal circuit.

VVA: Venturi Vacuum Amplifier.

VVC: Variable Voltage Choke relay or its control circuit.

VVV: Vacuum Vent Valve.

WAC: Wide-open throttle A/C Cutoff.

WOT: Wide-Open Throttle.

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